ThermaSource INC.
GEOTHERMAL CONSULTING SERVICES

TRUE GEOTHERMAL ENERGY COMPANY
KMERZ WELL NO. KA2-1
GEOTHERMAL DRILLING PROGRAM
COUNTY OF HAWAII

Submitted to:

Department of Land and Natural Resources
Honolulu, Hawaii

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TRUE GEOTHERMAL ENERGY COMPANY
KMERZ WELL NO. KA2-1
GEOTHERMAL EXPLORATION WELL PROGRAM

The following well program is designed to drill and complete a nominal 10,000′ geothermal exploration well in the KMERZ. (See Figure 001) Based on the results of prior drilling, a large degree of flexibility is built into the program. It should be clear that being an exploration well, the casing setting depths and drilling procedures are subject to change at any time. DLNR will be notified and updated as drilling progresses on any changes.

1. Install 30" conductor pipe in 42" hole to 60′ to 100′ or as deep as possible below ground level prior to rotary rig moving onto location. Cement conductor from total depth back to surface with redi-mix cement. If a burial cave or lava tube is encountered when setting the conductor pipe, further investigation is required prior to proceeding. Notify DLNR and consult with archaeologist. If conditions warrant, conductor installation may also be performed with rotary rig.

2. Construct 10′ x 10′ x 9′ deep cellar around conductor pipe with a cemented bottom and stairway exit toward front of rig. See attached Figure 002.

3. Move in rotary drilling rig to drill well. Center rig over conductor pipe and rig up. Drill 42" hole with bucket bit and install 30" conductor, if not installed prior to moving in. Add 30" OD extension to conductor pipe to bring it up under rotary table. Install flow line on conductor pipe to return mud to pits.

4. Notify DLNR upon startup of drilling of a pilot hole. Pick up an 8-1/2" bit on a 26" hole opener or reamer and run into the bottom of the conductor pipe. Center punch 8-1/2" hole and drill 8-10′. Pull out of hole and remove 26" hole opener or reamer. Run 8-1/2" bit and drill to 100′+/-. During the drilling of this 8-1/2" pilot hole progress should be monitored constantly to determine if a lava tube which may contain archaeological artifacts might be encountered directly under the rig. If the bit drops free for more than eight (8) feet then drilling will stop. If this drop occurs the hole will be flushed with clear water and a light source with video camera lowered into the hole to investigate the possibility of any archaeological value. If archaeological value is determined then drilling will stop and the rig moved. If no archaeological value is determined then provisions would be made to continue drilling. Drilling supervisor shall be on drill rig floor throughout complete pilot hole drilling operations.

5. Open 8-1/2" hole to 26" with 26" bit and drill with mud to 800-1000′ depending on geology. Maintain hole as straight as

Substitute Page

possible, take drift shots every 100'. Maximum rate of change 1 degree per 100'. Install mud loggers at surface to log entire well from 0' to total depth. Catch three clean and dry samples every 10'.

6. Rig up and run 20" casing to total depth as per attached 20" casing program with 20" stab-in float collar and float shoe on bottom.

7. Once 20" casing has been run to bottom, run in hole with stab-in tool on bottom of drill pipe and stab into float collar. Circulate hole clean with at least two full circulations.

8. Cement 20" casing through drill pipe as per attached program. Circulate cement back to surface between 20" and 30" casing. Observe cement level. If cement falls back in annulus, bring same back to surface with 1" pipe.

9. Wait on cement 8 hours.

10. Land 20" casing. Cut off and remove 30" conductor drilling nipple. Cut off 20" casing and weld on 20" S.O.W. x 21-1/4" 2000 psi wellhead. Install two 3" valves and diverter. Install 20" blow out preventer equipment as per attached Figure 003.

11. Test 20" casing and blow out preventer equipment to 1000 psi for 30 minutes.

12. Drill out cement and float collar and float shoe from 20" casing with 17-1/2" bit using mud. Drill 30' of formation and trip to pick up stabilization.

13. Continue to drill 17-1/2" hole as vertical as possible with mud to 3500'+/- as indicated by formation. Directionally survey well at least every 100'. If lost circulation presents severe problems, an aerated mud system may be utilized. Severe loss circulation zones should be cemented off prior to drilling ahead.

14. Once 17-1/2" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

15. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

16. Rig up and run 13-3/8" casing as per attached 13-3/8" casing program and running procedure. If lost circulation presents severe problems during drilling it may be necessary to set 13-3/8" pipe as a liner then tie it back to the surface rather than a full string of casing. See running procedure for alternative options.

possible, take drift shots every 100'. Maximum rate of change 1 degree per 100'. Install mud loggers at surface to log entire well from 0' to total depth. Catch three clean and dry samples every 10'.

6. Rig up and run 20" casing to total depth as per attached 20" casing program with 20" stab-in float collar and float shoe on bottom.

7. Once 20" casing has been run to bottom, run in hole with stab-in tool on bottom of drill pipe and stab into float collar. Circulate hole clean with at least two full circulations.

8. Cement 20" casing through drill pipe as per attached program. Circulate cement back to surface between 20" and 30" casing. Observe cement level. If cement falls back in annulus, bring same back to surface with 1" pipe.

9. Wait on cement 8 hours.

10. Land 20" casing. Cut off and remove 30" conductor drilling nipple. Cut off 20" casing and weld on 20" S.O.W. x 21-1/4" 2000 psi wellhead. Install two 3" valves. Install 20" blow out preventer equipment as per attached Figure 003.

11. Test 20" casing and blow out preventer equipment to 1500 psi for 30 minutes.

12. Drill out cement and float collar and float shoe from 20" casing with 17-1/2" bit using mud. Drill 30' of formation and trip to pick up stabilization.

13. Continue to drill 17-1/2" hole as vertical as possible with mud to 3500'+/- as indicated by formation. Directionally survey well at least every 100'. If lost circulation presents severe problems, an aerated mud system may be utilized. Severe loss circulation zones should be cemented off prior to drilling ahead.

14. Once 17-1/2" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

15. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

16. Rig up and run 13-3/8" casing as per attached 13-3/8" casing program and running procedure. If lost circulation presents severe problems during drilling it may be necessary to set 13-3/8" pipe as a liner then tie it back to the surface rather than a full string of casing. See running procedure for alternative options.

17. Cement 13-3/8" casing as per attached program. Circulate cement back to surface between 13-3/8" and 20" casings. Observe cement, if it falls back, bring level back to surface using 1" pipe.

18. Wait on cement 12 hours or until samples are set.

19. Land 13-3/8" casing. Remove 20" blow out preventer stack. Cut off 13-3/8" casing and install 12" x 21-1/4" 900 ANSI expansion spool wellhead with two 3" flanged outlets equipped with 3" 2000 psi wing valves. Install 12" 900 series blow out preventer stack with 12-1/4" bore as per attached Figure 004.

20. Test 13-3/8" blow out preventer stack to 1500 psi for 30 minutes.

21. Drill out all cement, float collar and shoe from the 13-3/8" casing with a 12-1/4" bit using mud. Drill 30' of formation and trip to pick up stabilization.

22. Drill 12-1/4" hole with mud or aerated mud as required by hole conditions to 6000-8000', the 9-5/8" casing point, as indicated by geologic staff. Lock up drilling assembly to maintain direction and angle as straight as possible to casing point.

23. Once 12-1/4" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

24. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

25. Rig up and run 9-5/8" casing as a liner equipped as required with external casing packer located 200-300' from bottom. Hang same using a double slip liner hanger with tie-back sleeve. Run 9-5/8" liner from total depth to hanger located 200' up inside of 13-3/8" casing as per attached 9-5/8" liner program and running procedure.

26. Once liner is hung, circulate hole clean through drill pipe with at least two full circulations.

27. Cement 9-5/8" liner and external casing packer from total depth back up to top of liner lap as per attached cementing program.

28. Once cement is in place, disengage from liner hanger and pull up 60' and circulate out excess cement.

29. Pull out of hole with liner hanging tool and run in hole with 12-1/4" bit and drill out cement from 13-3/8" casing to top of 9-5/8" liner lap. Test lap to 1000 psi only after cement has been in place 12 hours. Squeeze lap area if necessary to

obtain a 1000 psi squeeze pressure.

30. Trip for 8-1/2" bit and drill out excess cement from 9-5/8" liner down to top of float collar. Pressure up and retest 13-3/8" casing, liner lap and 9-5/8" casing to 1000 psi.

31. Drill out cement, float collar and float shoe from 9-5/8" casing using 8-1/2" bit and mud. Drill 30' of formation and circulate to change out mud for water. Re-install rotating head on blow out preventer stack for air drilling if not already installed for the drilling of the 12-1/4" hole.

32. Trip to pick up 8-1/2" stabilization. Drill 8-1/2" hole through production zone to total depth of 9,000'-12,000' using air or aerated water as a drilling medium.

33. Pull out of hole with drill pipe and test well for short term with rig on location.

34. If results appear commercial, pull out of hole and release rig for long production test or proceed ahead with attached 9-5/8" tie-back procedure to complete well with 9-5/8" tie-back, if 13-3/8" casing shows damage or excessive wear. If well test results prove that the flow rate from the well is not commercial then either deepen or redrill to obtain production.

35. Evaluate well and complete with either open hole or 7" slotted liner.

SPECIAL CONSIDERATIONS
AUXILIARY EQUIPMENT THAT SHOULD BE MAINTAINED WITH THE RIG

1. Six pen drilling recorders on drill floor with: a) string weight; b) rpm; c) rotary torque; d) rate of penetration; e) pump pressure; f) exit pressure. Additional real time monitoring of drilling parameters to be considered upon consultation with DLNR Staff.

2. Special rotating head with rubbers, capable of stripping 17-1/2", 12-1/4" and 8-1/2" bottomhole assemblies. Complete with spare rotating head stripper drive bushing assembly. Rotating head should be installed on top of hydril or at least on location, available for installation if necessary. Run cold water continuously on head while producing geothermal fluids.

3. Use tong torque assembly with torque gauge for making up collars to API torque requirements.

4. Temperature should be taken with every directional survey by running a maximum recording thermometer in the survey instrument.

5. Catch drill cutting samples (3 sets) every 10′, to be cleaned and sacked.

6. In and out temperatures, both of mud, air or aerated water, shall be recorded in the Tour Reports every 30′. All steam/water entries shall be recorded in the Tour Reports.

7. All lost circulation zones encountered shall be recorded in Tour Book recording both the depth at which the loss occurred, as well as the amount of fluid lost. All flows shall also be recorded giving depth and the amount of increase.

8. Periodic tests may be conducted to determine well potential. Drilling will be stopped and the hole evacuated to check for flow at lost circulation zones.

9. Upon completion, the well will be shut in by closing the lower master valve. The remainder of the blow out preventer equipment will then be removed.

10. Rotary table will be equipped with a torque gauge with visual display for driller.

HYDROGEN SULFIDE MONITORING AND ABATEMENT

Hydrogen sulfide monitoring should be maintained during the drilling of the well. Detectors should be placed on the rig floor, cellar area, and flowline region to detect and announce (with alarms and lights) the presence of hydrogen

sulfide. These monitors are typically provided by and maintained daily by the geothermal data loggers. Proper functioning of these monitors is essential in maintaining a safe working environment.

Hydrogen sulfide abatement equipment and materials, i.e. pumps and caustic soda, should be maintained on location when drilling with lighter than water drilling fluids, i.e. air or aerated mud systems.

Escape breathing equipment, as well as resuscitators shall be available on site with mud logging unit. Fans should also be available on the rig floor to clear H2S contaminated floor areas, making it safer to work.

PIPE AND BLOW OUT PREVENTER INSPECTION

The initial acceptance of drill pipe should be based on an IODC-API Class II specification inspection. All subsequent inspections should discard pipe with 30% wear or greater; i.e., use 30% where Class II states 20%.

The drill pipe should include:

1. Electromagnetic inspection of tubes (Sonoscope or Scanalog).

2. Wall thickness and cross sectional area (ultrasonic or gamma ray).

3. End area inspection (electronic or magnetic particle).

All drill collar end areas should be magnetic particle inspected every 14 days or every 9 days while drilling with production or drilling with air or aerated mud systems.

All BOPs should be inspected for wear by the manufacturer or an authorized agent prior to installation. All BOPs should be tested after installation prior to drilling out cement.

Remind service companies furnishing bottomhole assemblies that their equipment should be magna-fluxed prior to delivery.

AIR EQUIPMENT REQUIREMENTS

Minimum air and pressure requirements are 4500 SCFM at 1000 psig for rotary drilling 12-1/4" hole below 13-3/8" casing.

Minimum air and pressure requirements are 3000 SCFM at 1000 psig for rotary drilling below 9-5/8" casing.

Hook-up lines, air meter, and scrubber, misting pump with minimum capacity of 10 gpm, and operating personnel will be furnished by the air contractor. Use Union Oil's UniSteam corrosion inhibitor while drilling in steam, to be injected into the drill pipe. The mixture for UniSteam is as follows:

Steam lbs/hr	Injection
0-20,000	5 gal UniSteam-10/BBl water
20,000-40,000	10-15 gal UniSteam-10/BBl water
40,000-150,000	20-35 gal UniSteam-10/BBl water
150,000+	40 gal UniSteam-10/BBl water

PROCEDURE FOR RUNNING AND CEMENTING 13-3/8" CASING

1. Drill to casing depth.

2. Circulate for 2-3 hours, two complete circulations to clean hole of cuttings.

3. Pick up excess drill pipe needed to stab into float collar for cementing the 13-3/8" casing.

4. Make short trip and circulate for 1-2 hours.

5. Pull out of hole and rig up to run 13-3/8" casing. Run multi-shot survey while pulling out of hole if necessary. If loss circulation has not been a severe problem in drilling the 17-1/2" hole, then proceed ahead to step 8 and run 13-3/8" casing as a full string. If loss circulation has presented problems, then proceed to step 23 and run 13-3/8" as a liner with tie-back string.

6. Run 13-3/8" casing grades, weights and thread design as indicated on attached detailed sheet with stab-in collar 40' from float shoe on bottom with centralizers located one in middle of bottom two joints and then one every other collar upward omitting any from the top 200'.

7. Set casing in elevators on spider. Do not set casing slips. Drop centralizing ring of 13-3/8" casing inside 20" wellhead. Install return hoses from 20" wellhead to mud pits.

8. Rig up with landing plate on top of 13-3/8" casing. Run drill pipe into 13-3/8" with stab-in sub on bottom. Stab into collar and rig up to circulate. Tie down drill pipe.

9. Circulate for 3 hours, or at least two full circulations, to clean up and cool down hole.

10. Rig up to cement.

11. If loss circulation is a problem, pump 20 BBls CaCl2 water, 10 BBls fresh water, 20 BBls sodium silicate, followed by 20 BBls viscous Geo-Gel mud spacer.

12. Pump cement without any additional spacers. Pump stage 1 consisting of Class G perlite blended 1:1 with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump this cement until you see returns of cement at the surface. If loss circulation has been a problem, the cement may have to be changed to a spherelite blended cement, see Note below.

13. Pump stage 2 cement: Class G cement with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu

ft and shut down again for 5-10 minutes before pumping last 30 cu ft. Check for fall back in annulus each time. Pull out of stab-in shoe and clear drill pipe, dropping all excess cement from drill pipe on top of float collar.

14. Rig down circulating equipment and pull out of hole with drill pipe.

15. Hook up to 13-3/8" casing elevators and pick up slightly to remove spider, then center 13-3/8" casing in stack.

16. Drain blow out preventer equipment after 30 minutes from the time cement was in place.

17. Wait on cement 12 hours before landing casing. Check for cement fall back in annulus periodically. Bring cement back to surface using 1" pipe if necessary.

18. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve and nipple up blow out preventer equipment as in attached Figure 004.

19. Test blow out preventer equipment to 1000 psi.

20. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

PROCEDURE FOR RUNNING & CEMENTING 13-3/8" AS A LINER AND TIE-BACK STRING

1. Follow steps 1-4 above.

2. Pick up 13-3/8" liner. If circulation was never achieved, then a stage collar should be installed at approximately 2000'. Install cement basket type centralizers in the middle of the bottom two joints and one just below stage collar. Install one cement basket type centralizer to be located 20' up inside 20" casing shoe.

3. Run liner in hole and hang same 100' up inside of 20" casing with shoe just off bottom.

4. Attempt to circulate with two times total volume of fresh water. If unsuccessful, then proceed with cement job.

5. Pump 20 BBls CaCl2 water and 10 BBls fresh water, followed by 20 BBls sodium silicate, 20 BBls Geo-Gel flush, then cement slurries for stage 1. Follow stage 1 cement with 200 cu ft of stage 2 cement.

6. Release plugs after stage 2 cement and open cementing ports if stage collar is run.

7. Circulate through stage collar. Repeat preflush prior to pumping cement. Pump stage 1 and stage 2 cement as in prior cement job on bottom section of 13-3/8" liner.

8. Release plugs and displace cement and plugs down hole to close stage collar.

9. Release hanger and pull out of hole with setting tool. Wait on cement for 6 hours.

10. Run in hole with 17-1/2" bit and clean out excess cement, if any, from the top of the 13-3/8" liner.

11. Test lap to 750 psi. If unable to get a test, trip to lay down bit, run in open ended. Squeeze lap with Class G cement blended with 40% silica flour and 0.5% CFR-2 using pipe rams.

12. Re-squeeze until a squeeze pressure is achieved. Fill hole with water.

13. Drill out excess cement with 17-1/2" bit and retest lap to 750 psi.

14. If successful in testing lap, run in hole with 12-1/4" bit and 13-3/8" casing scraper to clean out tie-back sleeve.

15. Pick up 13-3/8" tie-back with float collar located 40' above tie-back stinger on bottom.

16. Run tie-back string in hole and land same in sleeve at hanger.

17. Circulate around with fresh water, then run cement slurry. Use top plug only.

18. Wait on cement 6 hours. If after 6 hours cement is not to surface level in 13-3/8" x 20" annulus, insert 1" tubing and bring it back to surface with cement.

19. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve, and nipple up blow out preventer equipment as in attached Figure 004.

20. Test blow out preventer equipment to 1000 psi for 30 minutes.

21. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 5% lime, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 82.2#/cu ft (11 ppg). Slurry yield is 3.21 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

9-5/8" LINER RUNNING PROCEDURE

The drilling program for Well KA2-1 has been written in such a way as to handle all situations that occur during the drilling. Due to the remote location and shipping requirements we must consider all possible hole conditions. These conditions that should be anticipated are listed in order of increasing severity as follows:

1. The 12-1/4" hole is drilled with little or no loss circulation encountered. Due to lost circulation encountered in drilling it would be highly probable that loss of circulation may occur during the cementing of the 9-5/8" liner.
   In this situation where lost circulation has not presented a significant problem during drilling, I feel that a conventional method should be employed in the running and cementing procedure for the 9-5/8" liner. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER" should be used.

2. The 12-1/4" hole is drilled with air, aerated water or mud, with moderate loss circulation, that is loss circulation encountered in several zones which could be sealed with cement or LCM, or partial loss circulation zones which may take fluid periodically during drilling operations. Probability of lost circulation during cementing is high and should be anticipated.
   In this situation a certain amount of caution should be used in running and cementing the 9-5/8" liner to insure a competent cement job. A 9-5/8" liner utilizing a multi-stage cement collar strategically located could assist in obtaining an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITH MULTI-STAGE CEMENTER" should be used.

3. The 12-1/4" hole is drilled using air or aerated water because of complete loss of circulation during the drilling. Sealing of these loss circulation zones prove to be unsuccessful or extensive causing a great loss of time therefore air or aerated fluid is used to drill the well. Probability of loss circulation during the cement job is high, therefore extreme methods of cementing the liner should be used.
   In this situation where major problems exist in the well, extreme procedures and technologies should be employed to insure an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER" should be used.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000-7000′ dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60′ of the hanger. Use T-Bar rigid centralizers totally in bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600′, 1800′ and 3400′ above shoe joint if required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is encountered, pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours

pumping time at 350 degrees F. Use 100% excess. If lost circulation is a problem, cement may be required to be changed to a spherelite blend. See note at bottom of this procedure. Pump stage 1 as per precalculated volumes.

13. Pump stage 2: Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degrees F. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu ft and shut down again for 5-10 minutes before pumping the last 30 cu ft.

14. Once all cement has been pumped then rig down circulating equipment, hang liner and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

15. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

16. Trip to change bits to 8-1/2" and clean out cement from inside of the 9-5/8" liner top.

17. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

18. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud.

19. Circulate to clean hole and then displace mud in hole for water.

20. Trip out of hole to pick up stabilization.

21. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per cu ft (11.8 ppg). Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi,
Tension: 1,122,000 lbs.

L-80, 53.5 ppf, Buttress, Burst: 6330 psi, Collapse: 3810 psi
Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi,
Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITH MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000 - 8000' dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60' of the hanger. Install multi-stage cementer in a strategic location in the liner string. The location of the multi-stage cementer should be such that the bottom portion can be cemented successfully without loss circulation. The upper portion can then be cemented after the bottom has had time to set without any loss circulation during cementing. A probable location is just above the loss circulation zones. If the hole was air drilled a good location would be approximately 1200' above the casing shoe. Use 12" T-bar rigid centralizers totally in the bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600', 1800', and 3400' above shoe joint as required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after stage 1 cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is a problem then pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium

silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 4-5 hours pumping time at 350 degrees F. Pump in calculated volume to fill the annulus of the 12-1/4" hole x 9-5/8" liner from the liner shoe to the stage collar with 100% excess, with approximately 200 cu ft of tail cement consisting of Class G cement blended with 40% silica flour, 3% gel and friction reducer. If loss circulation is a problem, cement may be changed to a spherelite blend. See note at the bottom of this procedure.

13. Pump stage 1 cement and drop dart for wiper plug. Displace cement with water. Bump plug and open multi-stage cementer.

14. After the stage collar has been opened then circulate out excess cement. Circulate and cool hole for 2 hours prior to pumping stage 2 cement. Hang liner at this point.

15. Pump in 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

16. Pump in 220 BBls of viscous Geo-Gel mud preflush.

17. Pump in stage 2 cement without any water spacers. Pump Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degress F. Pump in calculated volume of cement to fill 12-1/4" hole x 9-5/8" liner to lap area without excess. Calculated volume should include a 200 cu ft tail slurry of Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours of pumping time at 350 degrees F. Displace cement with water.

18. Once all cement has been pumped then rig down circulating equipment and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

19. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

20. Trip to change bits to 8-1/2" and clean out cement from inside of 9-5/8" liner top.

21. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

22. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud or water.

23. Circulate to clean hole and then displace mud in hole for water if necessary.

24. Trip out of hole to pick up stabilization.

25. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per sack of cement. Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5 ppf, Buttress, Burst 6330 psi, Collapse: 3810 psi, Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER

1. Drill to casing depth at approximately 6000 - 8000′ dependent on temperature and geology.

2. Circulate for 2-3 hours.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in attached detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of bottom two joints and then one every other collar upward to within 60′ of hanger. Use T-Bar rigid centralizers in the bottom portion of the string and then as required in the upper portion. If lost circulation is a problem or the hole has been drilled with air or aerated water then CTC external casing packer should be positioned in string 200-300′ from bottom with Halliburton hydraulic stage cementer located above packer. Run casing adjuster at 600′, 1800′, and 3400′ from shoe joint as required. A T-Bar centralizer should be located above and below packer.

9. Run liner equipment. See attached Pre-Job Recommendations.

   Check all equipment to be run on 9-5/8" liner.
   a. Use Instructions & Operations Sheet TE 7.00381. Measure all parts OD and ID.
   b. Check threads on all tools.
   c. Midway liner hanger running tool. Stinger must be reduced down to 3" OD 2.75 ID and run 10-12.5" below bottom of liner hanger as shown on print TE 7.00378. This is when the liner hanger string is at the bottom of its travel.
   d. Part numbers are given on print TE 7.00377 for tools. ID and OD for SR Plug set is given on print TE 7.00379 OD and OD for HOS Cementer are given on print TE 7.00380.

e. All parts and number should check with prints.
f. HOS Tool has four shear pins that will take 2880 psi over Hydrostatic pressure to open it, two other pins are with the tool. Each pin adds 712.5 psi pressure to shear. Open pressure may be adjusted as needed.

10. Installing equipment onto casing strings. See attached Recommendations During Job for further details.

a. Guide shoe.
b. Centralizers on two joints.
c. Float collar.
d. Centralizers as per program.
e. Casing.
f. CTC Packers 200' off bottom.
g. One joint with centralizer in middle.
h. HOS Cementer.
i. Centralizers as per program - run casing adjusters located 1500' and 3000' from shoe.
j. Casing to top of liner. Fill liner as going in hole.
k. Make up SR Baffle Collar on bottom of liner hanger.*
l. Take O-ring off SR plug set and put on SR Baffle Collar.
m. Make up SR plug set on Baffle Collar and tighten at plug set to Baffle Collar. Be sure all parts are tight.
n. Circulate the liner at 3-4 BPM. Stop and circulate 2-3 times while running in hole with liner assembly on drill pipe.

*Be sure there are no areas of drill pipe on liner hanger less than 2.75 ID.

11. Cement liner in three stages.

a. Calculate volume of cement for bottom stage. (200 ft of 12-1/4" hole and 9-5/8" annulus plus shoe joint volume and volume to inflate CTC Packer).
b. Mix cement for above.
c. Pump cement for 200' annulus and shoe joint. Release first stage dart 809.81266 and pump cement for inflated CTC. (Cement to inflate packer should be Class G with 40% silica flour and friction reducer, no perlite.)
d. Pump 10 BBls spacer then displace with mud at 3-4 BPM until 10 BBls before dart should land in SR lower plug - slow rate to 2 BPM. Pressure should go to 1800 psi and plug release.
e. Displace shut off plug at 5-6 BPM until 30 BBls before plug lands. Then pump at 1-2 BPM.

f. When shut off plug lands in shut off baffle, pressure up to 500 psi and shut down.

12. Inflate CTC Packer with cement. See attached Recommendations During Inflation Sequence for further details.

    a. Check volume of displacement tank.
    b. Increase pressure slowly to 700 psi and shut down.
    c. Increase pressure slowly to 800 psi.
    d. Increase pressure slowly to 900 psi or until tool opens.
    e. Pump in 2-5 cu ft of cement per stage until CTC packer is inflated.
    f. Increase pressure to 1000 psi to close CTC packer.
    g. With pressure at 500 psi, check volume of cement needed to inflate tools.
    h. Pressure up to 2800 psi and open HOS.
    i. Circulate well as needed.
    j. Cement liner as per program. Pump spacer. Pump cement.
    k. Release dart for shut off plug. Pump at 4-5 BPM. Pump 10 BBls spacer - then mud.
    l. Displace to within 10 BBls of plug, slow to 2 BPM.
    m. Pressure to 1950-2000 psi to release plug.
    n. Displace at 4-5 BPM.
    o. When plug lands in HOS, pressure up to 3000 psi to close tool. You may have to go to 3500 psi. Hold pressure for 2 minutes.
    p. Release pressure if holding; back off liner hanger tool.
    q. Come out of hole with tools.
    r. Wait 24 hrs and drill out.

13. Rig down circulating equipment, pull out of hanger with drill pipe and pull up 90′ and circulate out excess cement leaving 90 linear ft of cement on top of liner top.

14. Wait on cement for 12 hrs. Run in hole with 12-1/4" bit to top of liner and circulate to clean out excess cement. Wait 24 hrs from the time cement was in place and pressure test lap to 1000 psi. Squeeze if necessary.

15. Trip to change bits to 8-1/2" and clean out cement from inside the 9-5/8" liner top.

16. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary.

17. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 30′ of formation.

18. Circulate and change out mud system for water.

19. Trip to pick up stabilization.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 88.3lbs/cu ft (11.8 ppg). Slurry yield is 3.16 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

CASING PROPERTIES

L-80, 47ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5ppf, Buttress, Burst: 7930 psi, Collapse: 6620 psi, Tension: 1,286,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PRE-JOB RECOMMENDATIONS

1. In close clearance (1/2"-1") installations:

    a. Run a casing scraper.
    b. Drill open hole section with a stabilized packed hole assembly if possible.

2. In liner installations, notify CTC of type of liner equipment before packers are shipped.

3. Insure that everyone involved understands the Payzone Packer system and specific duties they are to perform.

4. Obtain all pertinent well data, including:

    a. Minimum wellbore restriction (should be 1/2" greater than packer OD).
    b. If casing damage is suspected, run a microscopic caliper and/or casing scraper.
    c. Calipered hole size in zone of interest should not exceed maximum recommended hole size. Use "Hole Size vs. Recommended Inflation Pressure Chart" to set pressure control valve.
    d. If junk has been lost in hole it should be fished or driven to below Payzone setting depth.
    e. Clients maximum allowable surface pressure (burst strength of casing with a safety factor), should be obtained prior to setting shear pin.
    f. If hole size adjacent to end assemblies is more than 1" larger than packer OD run one centralizer above and below each packer.

5. Inspect auxiliary equipment.

    a. Float shoe.
    b. Float collar.
    c. Bottom cement wiper plug (proper size, rupture diaphragm).
    d. Two top cement wiper plugs (proper size, no rupture diaphragm).
    e. Pressure recorder (5000 psi scale if possible).
    f. Chicksan lines.
    g. Cementing head.
    h. Verify that adequate inflation cement is available.
    i. Obtain a dry sample of all cements used on the job.

6. Review primary cementing plans and calculate theoretical bottom hole pressure during cementing operations. If expected pressures approach fracture gradient, pressure anomalies are probable and bottom wiper plug should not be run so that knockoff rod protection stays intact.

7. Calculate displacement volumes. Know at what displacement the following events should take place:

    a. Bottom wiper passes packers (knockoff rods).
    b. Bottom wiper lands in float collar.
    c. First top wiper passes packer.
    d. First top wiper lands in float collar, and
    e. Top of inflation cement (second top wiper plug) relative to upper packer.

8. Total inflation pressure is critical to Payzone Packer performance. Before starting a job know and/or calculate: 1. hydrostatic pressure inside and outside the casing at packer setting depth, 2. pore pressure, 3. fracture pressure, 4. maximum recommended differential inflation pressure from hole size vs pressure chart, 5. resultant effective stress.

    a. Total inflation pressure equals:
        1. Hydrostatic pressure inside casing (packer depth) + Applied surface pressure

        OR

        2. Hydrostatic pressure outside casing (packer depth) + Differential inflation pressure

    b. Differential inflation pressure equals:
        1. Total inflation pressure minus Pressure outside casing (packer depth)

        OR

        2. Applied surface pressure minus Balance pressure

    c. Balance pressure equals:
        1. Surface pressure required to offset "U" tube pressure
        2. Approximated by surface pressure (pumping at 1/4-1/2 BBl/min) just prior to plug bump.

    d. Radial effective stress (Seal Load, Wellbore Support) equals:
        Total inflation pressure minus pore pressure.
        -In all cases the differential inflation pressure must be within the hole size vs differential pressure capabilities of the equipment.
        -For zone isolation the radial effective stress (seal load) should be at least 500 psi and total inflation pressure must be less than fracture pressure.

9. Review casing tally. Re-tally casing during run-in if necessary. This is critical if positioning log is not to be run.

10. Make up casing according to API specifications with proper torque and API pipe dope.

Note: It is extremely difficult to properly inflate packers with a casing leak.

11. Epoxy thread lock should be used on packer/casing connections, float collar, and float shoe.

12. A minimum number of only high quality (API approved) centralizers be run below packer(s). If pipe is to be reciprocated, and hole size adjacent to end assemblies does not exceed packer OD plus 2", spacing between packers and centralizers should be greater than reciprocation stroke. Do not place scratchers in this area.

13. If positioning is critical, packers should be logged into position.

14. Insure that cement has adequate pump time.

15. Inflation cement should have an API water loss of less than 150 cc. Inflation cement must not contain lost circulation material.

RECOMMENDATIONS DURING JOB

1. Verify that external cementing aids (centralizers, scratchers, etc.) are properly installed.

2. Run-in speed 1 ft/sec (may be prudently increased to 2 ft/sec per Steps 3 and 4 below).

3. Monitor returns, if more than 30' of casing is run before receiving full returns - SLOW DOWN.

4. Monitor weight indicator - excessive weight loss during run indicates that run-in speed may be too fast.

5. Pressure test lines before beginning cement job. Repair all leaks no matter how small.

6. Verify that wiper plugs are dropped at proper time in proper sequence.

7. Monitor returns during entire job.

8. Monitor mixing and pumping of inflation cement. Verify volume and weight of inflation cement. Batch mix if possible.

   Note: If inflation cement is not batch mixed, monitor BBl counter, but do not rely on its accuracy. Insist that mix water be accurately measured from tanks and that cement density remains constant and proper. (If cement is mixed at proper weight, mix water volume is an accurate indicator of cement volume.)

9. Insist that plug drop be verified via tattle-tale, flag or radioactive techniques.

10. Monitor displacement volume, pump rate and surface pressure during entire displacement process.

11. Determine balance pressure during last 5 BBl of displacement. (Slow displacement to 1/4-1/2 BBl/min and record pressure.)

12. Required displacement volume will normally exceed theoretical casing volume. If mud is used for displacement, expect up to 6%.

RECOMMENDATIONS DURING INFLATION SEQUENCE

1. When first plug lands in float collar:

2. Open shear valve in first or bottom packer by rapidly applying appropriate surface pressure, i.e. balance pressure plus pressure rating of shear valve. (Monitor volume displaced.) Stop pumps and monitor pressure decline, increase pressure by 200 psi or as needed to open valve. Record volume in displacement tanks.

   NOTES:

   a. Flow rate into Payzone packers is relatively slow (1/4 BBl/min). Therefore, it is generally impractical and not advisable to pump continuously during inflation. The preferred procedure is to rapidly increase surface pressure, stop pumping and monitor pressure decline. When the packer is full, the pressure decline will stop.

   b. The expected pressure response during inflation is a function of several variables. In general the following reduce the distinctiveness of the pressure response.
      1. Increased well depth.
      2. Compressability and volume of fluid within the casing string.
      3. Large diameter casing.
      4. Viscosity of inflation cement.
      5. Small inflation volume.

      For example, the pressure response during inflation of a 9-5/8" packer at 12,000' with 3/4 BBl of 16.4 lbs/gal cement may be non-distinct while inflation of a 5-1/2" packer with 1 BBl at 6000' would be very distinct.

3. When packer is completely inflated (surface pressure remains constant), apply final desired inflation pressure.

   a. Record volume pumped and hold pressure for 5-10 min.

   b. Bleed surface pressure slowly back to balance pressure (and/or point 1a above and record flowback volume.

   c. Release pressure slowly.

Note: In shallow (less than 7000') unconsolidated sands, the hole size often enlarges as the packer re-stresses the sand. In these installations, final inflation pressure should be adjusted or reduced in accordance with hole size.

This may be done by converting inflation volume to equivalent hole diameter and using "Hole Size vs Recommended Inflation Pressure Chart".

THINGS TO AVOID

1. Avoid using bottom wiper plugs whenever possible. This is critical if bottomhole pressures during the cement operation are likely to exceed frac pressure.

2. Avoid using spacer fluids below inflation cement because volumetric error and/or pressure anomalies may result in mud-filled packers.

   Note: The use of lightweight spacer fluids below the inflation cement imposes a hydrostatic differential pressure across the valve collar equal to [Weight of cement in annulus (lbs/gal) minus weight of spacer fluid below packer (lbs/gal)] multiplied by .052 times height of spacer fluid below packer.

3. Do not exceed fracture pressure in isolation installations.

4. If spacer fluids are used as substitues for wiper plugs above inflation cement, increase cement volume to compensate for contamination of the upper 100' of inflation cement.

5. Do not use differential fill equipment because debris may enter casing. Some varieties of differential fill equipment must be opened via applied casing pressure prior to circulation. This is not compatible with our valve system.

6. Insist that liner hanger packoffs not be set prior to packer inflation.

7. Do not spud casing - circulate through bridges.

8. Do not use cement with more than 6% Plaster of Paris or Calseal cement.

9. Do not use loss circulation material in inflation cement.

PROCEDURE FOR RUNNING 9-5/8" TIE-BACK CASING
OPTIONAL

1. Kill well with cold water. Pick up Halliburton 9-5/8" EZSV cement retainer on drill pipe and run in hole to 300' below liner top. Set EZSV at this point.

2. Spot a 50 linear foot thick viscous gel pill on top of EZSV and 50 linear feet of cement on top of gel. Fill hole with water and circulate to cool and clean hole. Make appropriate changes to wellhead assembly.

3. Run 9-5/8" casing scraper to clean out liner tie-back sleeve.

4. Rig up and run 9-5/8" tie-back string to top of liner with float collar 40' (1 joint) above stab-in tool on bottom. Stab-in tool will be equipped with slip. Stab into liner, engage slips on the 13-3/8" and pull up on tie-back to 200,000 lbs to pretension tie-back.

5. Cement tie-back as per attached cementing program. Bring cement back to surface between 9-5/8" and 13-3/8" casing, setting centralizer in 13-3/8" casing head before cementing.

6. Wait on cement 12 hours, then release tension.

7. Land 9-5/8" casing. Pick up 12" blow out preventer stack and install expansion spool (12" 900 x 10" 900) equipped with two 3" flanged outlets with 3" 2000 psi wing valves. Install 10" 900 Master Valve and 10" 900 x 12" 1500 adaptor spool and reinstall blow out preventer stack.

8. Test blow out preventer stack, 10" master valve, expansion spool and 9-5/8" tie-back to 1500 psi.

9. Pick up 8-1/2" bit and drill out excess cement and float collar. Work bit through lap area and retest to 1000 psi. Squeeze if necessary.

10. Drill out cement and clean out gel to top of EZSV.

11. Trip for EZSV picking tool and remove EZSV.

12. Return well to production and retest if necessary, using air to induce well to flow.

13. Lay down drill pipe, remove blow out preventer equipment,and move rig off, releasing rig.

14. Prepare for long term test.

15. Test well.

9-5/8" CASING PROPERTIES

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

FIGURES

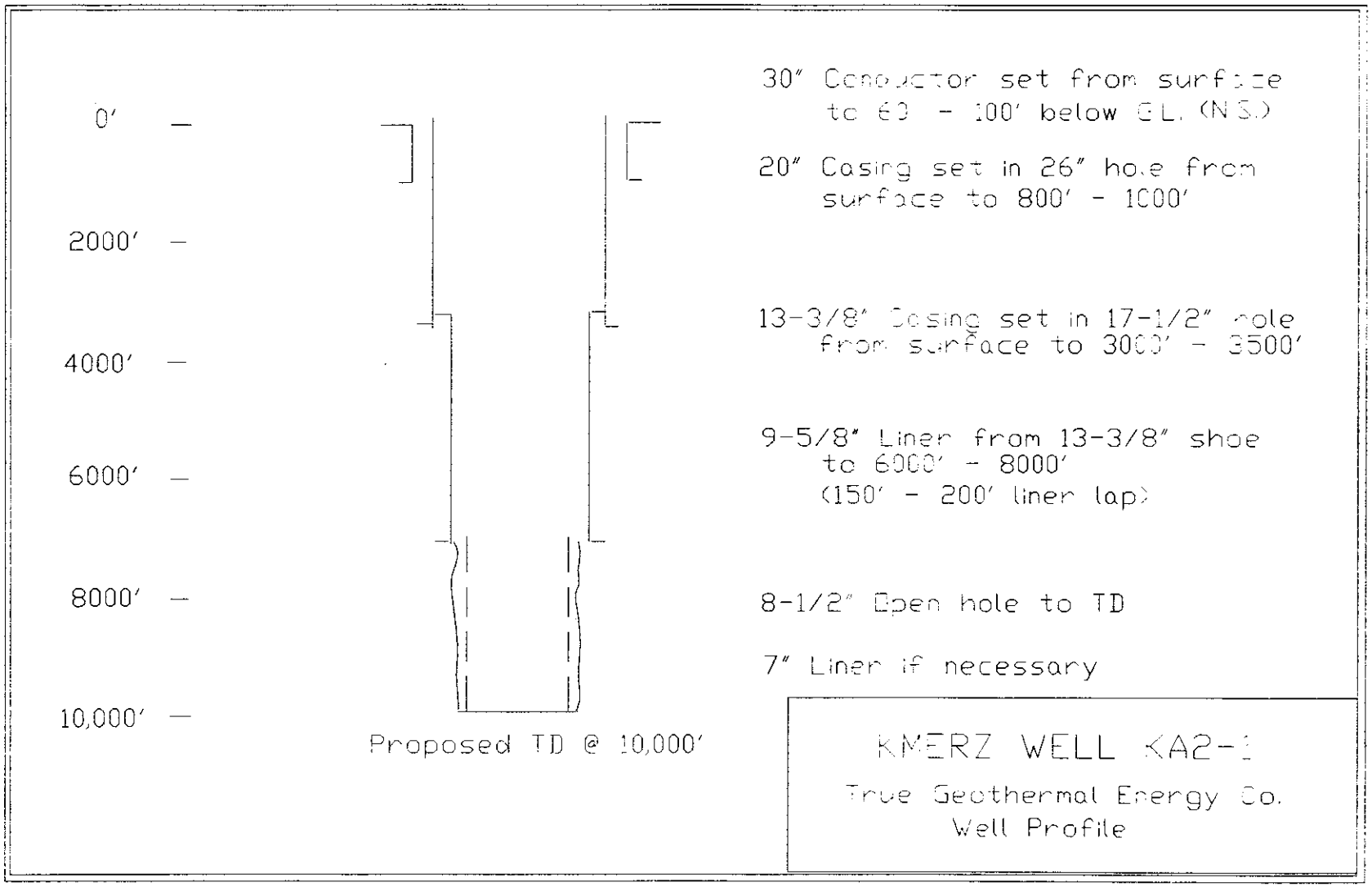

0'
2000'
4000'
6000'
8000'
10,000'
Proposed TD @ 10,000'
30" Conductor set from surface to 60 - 100' below G.L. (N.S.)
20" Casing set in 26" hole from surface to 800' - 1000'
13-3/8" Casing set in 17-1/2" hole from surface to 3000' - 3500'
9-5/8" Liner from 13-3/8" shoe to 6000' - 8000'
(150' - 200' liner lap)
8-1/2" Open hole to TD
7" Liner if necessary
KMERZ WELL KA2-1
True Geothermal Energy Co.
Well Profile

FIGURE 001

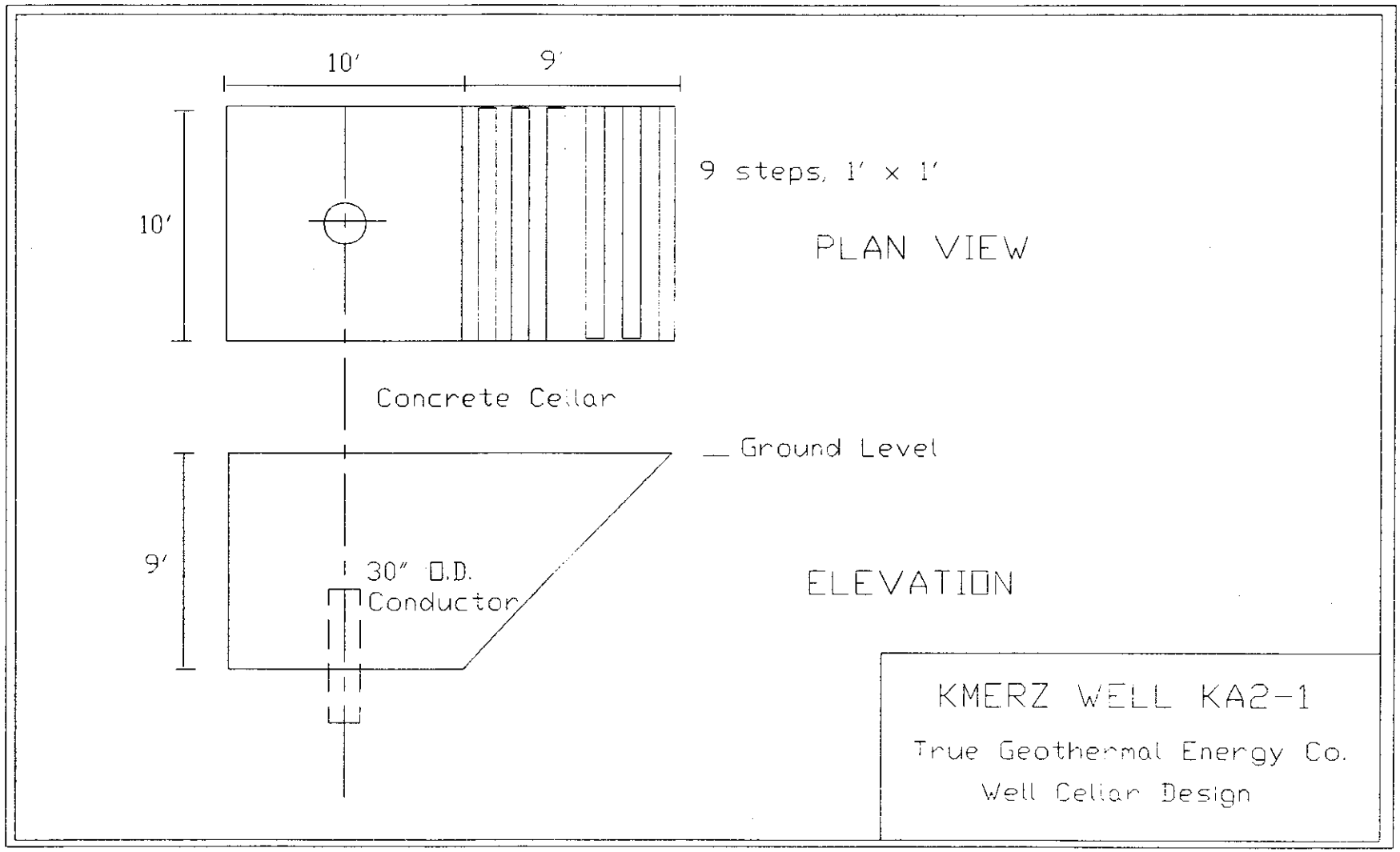

10'
9'
10'
9 steps, 1' x 1'
PLAN VIEW
Concrete Cellar
Ground Level
9'
30" O.D.
Conductor
ELEVATION
KMERZ WELL KA2-1
True Geothermal Energy Co.
Well Cellar Design

FIGURE 002

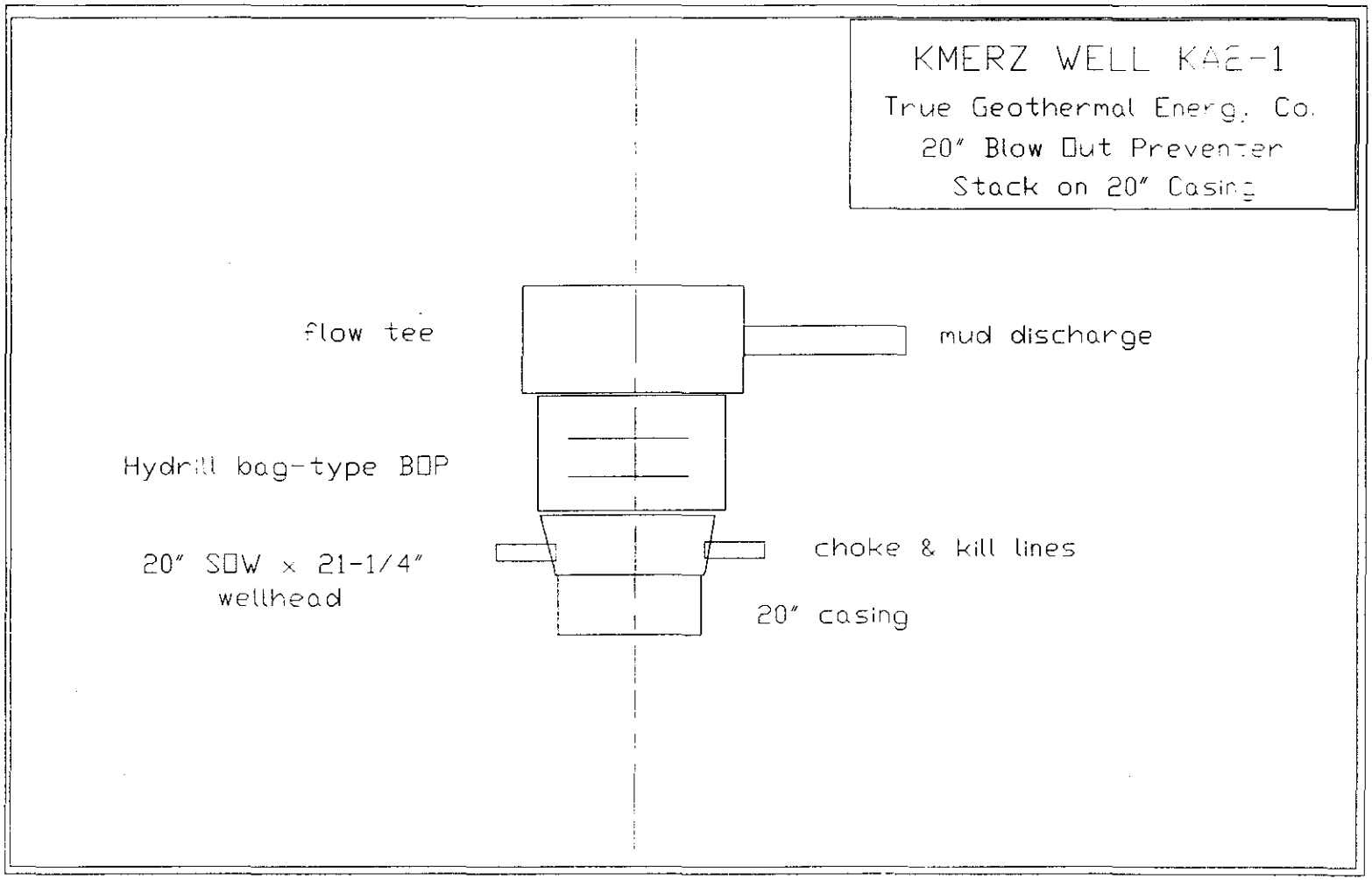

KMERZ WELL KAE-1
True Geothermal Energ. Co.
20" Blow Out Preventer
Stack on 20" Casing
flow tee
mud discharge
Hydrill bag-type BOP
choke & kill lines
20" SOW x 21-1/4"
wellhead
20" casing

FIGURE 003

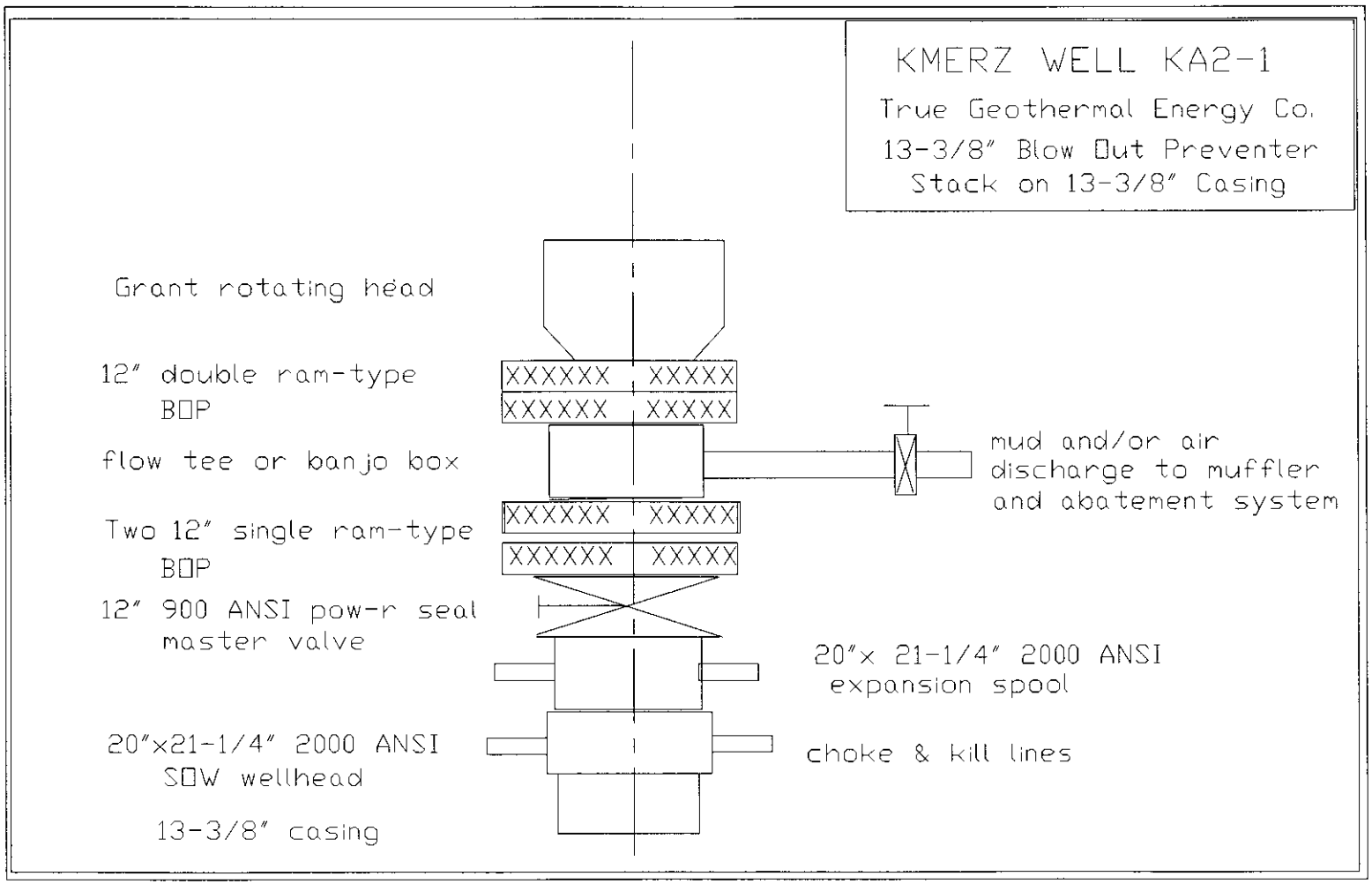

KMERZ WELL KA2-1
True Geothermal Energy Co.
13-3/8" Blow Out Preventer
Stack on 13-3/8" Casing
Grant rotating head
12" double ram-type
BOP
flow tee or banjo box
Two 12" single ram-type
BOP
12" 900 ANSI pow-r seal
master valve
20"x21-1/4" 2000 ANSI
SOW wellhead
13-3/8" casing
XXXXXX XXXXX
XXXXXX XXXXX
XXXXXX XXXXX
XXXXXX XXXXX
mud and/or air
discharge to muffler
and abatement system
20"x 21-1/4" 2000 ANSI
expansion spool
choke & kill lines

FIGURE 004

TABLES

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

CASING, CEMENTING AND BOP PROGRAMS

SIZE	DEPTH	WELL
20"	1000'	KA2-1

CASING PROGRAM

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-1000'	106.5	K-55	Buttress	3.31	9.21	1.64	9.99+
Casing Properties:							
Collapse-770 psi							
Burst-2320 psi							
Tension-1,683,000 lbs.							

DESIGN CONDITIONS

SURFACE BURST PRESSURE	2000	PSI	OUTSIDE MUD WT. (COLLAPSE)	9.95	PPG
INSIDE MUD WEIGHT (BURST)	9.5	PPG	INSIDE MUD WT. (COLLAPSE)	0	PPG
OUTSIDE MUD WEIGHT (BURST)	9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	14.5	PPG	BIAXIAL LOAD: COLL. ☐ BURST ☐	BOUYANCY: YES ☐ NO ☒	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2690 cu ft (838 sx) of Class G cement blended with 50 lbs of spherelite per sack of cement, 40% silica flour, 4% gel, 5% hydrated lime, 1.25% CFR-2 and 0.5% Halad-22A tailed with 400 cu ft (252 sx) of Class G cement blended with 40% silica flour and 3% CaCl2

	DESIRED TOP	EXCESS
	Surface	100%

SLURRY VOL. - CU FT / (SLURRY NO.)	2690		400	
SLURRY YIELD - CUBIC FEET/SACK	3.21 cu ft/sx		1.59 cu ft/sx	
SLURRY DENSITY - PPG	82.2#/cu ft(11 ppg)		118#/cu ft(15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Stab in float collar located 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 2 joints, then one every other tool joint to within 100' of surface.
2. Use centralizer cement baskets as required due to lost circulation.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Stab into float collar with drill pipe. Attempt to circulate with water.
2. Pump 200 cu ft CaCl2 water followed by 100 cu ft of fresh water, 200 cu ft Flo-chek, 200 cu ft Geo-gel, then cement slurries.

PRESSURE TESTING AND LANDING

1. Use 1" pipe in annulus of 20" AND 26" hole to bring cement back to surface if necessary.
2. Wait on cement 8 hours.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	2000	20"	See attached drawing	1500	1500	

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

CASING, CEMENTING AND BOP PROGRAM

CASING PROGRAM

SIZE	DEPTH		WELL
13-3/8"	3500'	Full String	KA?-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-3000'*	68	L-80	Buttress	2.03	1.95	1.51	6.44
3000-3500'**	72	L-80	Buttress	2.08	2.05	1.55	45.83
Casing Properties:*			Casing Properties:**				
Collapse-2260 psi			Collapse-2670 psi				
Burst-5020 psi			Burst-5380 psi				
Tension-1,545,000 lbs			Tension-1,650,000 lbs				

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000	PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	- 9.5	PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	- 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	- 14.5	PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

4257 cu ft (1723 sx) Class G cemetn blended 1:1 with perlite and 40% silica flour, 4% gel and 0.65% CRF-2. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hours pumping time at reservoir temperature.

DESIRED TOP: Surface — EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	4257		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft(13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run stab in float collar 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac-weld top of collars on bottom 2 joints.
5. Run 13-3/8" as full string or liner with tie-back as hole conditions dictate. See attached procedure.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 8 joints. Then turbo-type centralizer on every other collar from bottom to within 200' of surface.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. If lost circulation is a problem run casing as directed in attached procedure. Use sodium silicate preflush as directoed.
2. Cement through drill pipe.
3. Pump cement of Stage 1 until cement appears at surface, then pump stage 2 cement.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs or until samples have set.
2. Cut & remove 20" casing. Install 12" x 20" expansion spool and blow out preventer stack as in attached drawing.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	Rotating head & ram	1500	1500	1000

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH		WELL
13-3/8"	3500'±	Liner	KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
900-3000'	68	L-80	Buttress	2.01	1.95	1.49	8.68
3000-3500'	72	L-80	Buttress	2.07	2.05	1.53	45.83

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	-	9.5 PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE)	-	0 PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	-	9.5 PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]		BOUYANCY: YES [ ] NO [X]

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

3340 cu ft (1041 sx) Class G cement blended with 50# per sack of cement of spherelite, 40% silica flour, 5% hydrated lime, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A, tailed with 300 cu ft (189 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries retarded to give 2-3 hrs pumping time at reservoir temperature.

DESIRED TOP 900'± EXCESS 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	3340	300		
SLURRY YIELD - CUBIC FEET/SACK	3.21	1.59		
SLURRY DENSITY - PPG	82.2	118		
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs	2-3 hrs		
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above float shoe.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints.
4. Tac-weld top of collars on last 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hang liner 100' up inside 20" casing on drill pipe.
2. Run rigid centralizer cement baskets in middle of bottom 2 joints and one 10' up inside 20" casing and one just below stage collar if a stage is indicated.
3. Run centralizers every other tool joint to bottome of 20" casing.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump 20 cu ft CaCl2 water and 100 cu ft water, followed by 200 cu ft Flo-Chek the 200 cu ft of Geo-gel, then cement slurries.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 8 hrs. Clean out cement from top of 13-3/8" liner. Test lap to 1000 psi. Squeeze lap if necessary. Clean out and retest until a test is obtaned.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
		No change until tie-back run				

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM — SIZE: 13-3/8" | DEPTH: 900'± | Tie-Back | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-900'	68	K-55	Buttress	1.76	1.67	5.04	25.25

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1059.8 cu ft (666 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

			DESIRED TOP	EXCESS
			Surface	30%
SLURRY VOL. - CU FT / (SLURRY NO.)	1059.8			
SLURRY YIELD - CUBIC FEET/SACK	1.59			
SLURRY DENSITY - PPG	118			
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 13-3/8" for wellhead.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	See attached drawing	1500	1500	

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM — SIZE: 9-5/8" | DEPTH: 7000' | Liner | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
3300-5300'	40	L-80	Buttress	2.04	1.97	1.08	6.08
5300-6500'	43.5	L-80	Buttress	2.17	2.30	1.16	13.71
6500-7000'	47	L-80	Buttress	2.30	2.29	1.36	47.74

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000	PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
INSIDE MUD WEIGHT (BURST)	- 9.5	PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	- 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	- 14.5	PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2000 cu ft (810 sx) of Class G cement blended 1:1 with perlite and 40% silica flour, 4% gel, and 0.65% friction reducer. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hrs pumping time at reservoir temperature. DESIRED TOP: To liner top | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	2000		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft (13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 80' (2 joints) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints as well as threads on float collar and shoe.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hand liner 200' up inside 13-3/8" casing with drill pipe.
2. Run rigid centralizers in middle of bottom 4 jonts and then 1 turbo type centralizer every collar to within 200' of top.
3. Run stage collars and external casing packer as in attached procedures.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump cement and preflush as in attached procedures.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs. Clean out cement from top of 9-5/8" liner. Test lap to 1000 psi. Squeeze lap if necessary to obtain good pressure test.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
		No change until tie-back run				

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM — SIZE: 9-5/8" | DEPTH: 3300'± | Tie-Back | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-3300'	40	L-80	Buttress	2.10	1.92	2.34	7.17

DESIGN CONDITIONS

SURFACE BURST PRESSURE	– 3000	PSI	OUTSIDE MUD WT. (COLLAPSE) –	9.5	PPG
INSIDE MUD WEIGHT (BURST)	– 9.5	PPG	INSIDE MUD WT. (COLLAPSE) –	0	PPG
OUTSIDE MUD WEIGHT (BURST)	– 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) –	9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	– 14.5	PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION AND NUMBER:

1140 cu ft (704 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

		DESIRED TOP	EXCESS		
		Surface	30%		
SLURRY VOL. - CU FT / (SLURRY NO.)	1140				
SLURRY YIELD - CUBIC FEET/SACK	1.62				
SLURRY DENSITY - PPG	116				
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs				
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run centralizers in middle of bottom joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 9-5/8" for expansion spool and blow out preventers.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	1500	8-1/2"	See attached drawing	1500	1500	1000

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

MUD

MUD, LOGGING, WELLHEAD & DIRECTIONAL PROGRAMS

WELL: KA2-1

DEPTH INTERVAL	MUD TYPE	WEIGHT	API FLUID LOSS	YIELD POINT	PH	
0-100'	Gel and water	65#/ft³	---	15	9.0	
100-1000'	Gel and water or air*	70#/ft³	10cc	15	9.0	
1000-3500'	Gel and water or air*	70#/ft³	10cc	15	10.0	
3500-7000'±	Gel and water or air*	70#/ft³	3.2cc	15	10.0	
7000-T.D.	Water or air*	65#/ft³	or 3000 cfm			

REMARKS
*If unable to maintain circulation due to lost circulation, first attempt to aerate system, then attempt to drill with air with rotary bit or air hammer (see attached). If misting is required, it may be necessary to increase air volume 30%. Misting mix should be fresh water mixed with 2-6 gal/10BBls of Magcobar Foamer. Maintain a solution pH above 10.0 to inhibit corrosion. Use Unisteam as outlined in special considerations.

LOGGING

DEPTH INTERVAL	LOG TYPES	LOG SCALES
100-1000'*	Temperature log & logs as directed	1" and 5" = 100'
1000-3500'*	Temperature log & logs as directed	1" and 5" = 100'
3500-7000'	Temperature log & logs as directed	1" and 5" = 100'
7000-T.D.	Temperature log & logs as directed	1" and 5" = 100'
0-T.D.	Samples every 10'	

REMARKS
All logs to be determined by geologist.
*Apply for waiver requiring E-log on these sections of the well.

WELLHEAD

API NOMINAL SIZE	WORKING PRESSURE PSI	TYPE	MAKE
26"	100 psi		
20" S.O.W. x 21-1/4" 2000	2000 psi	*Weld on wellhead	WKM
21-1/4" 2000 x 12" 900	3000 psi	21-1/4" x 12" expansion spool with two 3" 2000 outlets	WKM
12" x 12"	3000 psi	12" 900 Ansi WKM Pow-R-Seal master valve	WKM

REMARKS

DIRECTIONAL OR STRAIGHT-HOLE

Drill hole as straight as possible, taking directional shots every 100'± from 0-7000' and on dull bits after 7000'. 0-3500' maximum deviation to be 5°, maximum rate of change to be $1\frac{1}{2}$° per 100'. 3500-7000' maximum deviation to be 8°, maximum rate of change to be $1\frac{1}{2}$° per 100'. 7000-T.D. monitor without control.

ThermaSource INC.
GEOTHERMAL CONSULTING SERVICES

TRUE GEOTHERMAL ENERGY COMPANY
KMERZ WELL NO. KA2-1
GEOTHERMAL DRILLING PROGRAM
COUNTY OF HAWAII

Submitted to:

Department of Land and Natural Resources
State of Hawaii

October 1993

725 Farmers Lane • P.O. Box 1236 • Santa Rosa, California 95402 • (707) 523-2960 • FAX (707) 523-1029

TRUE GEOTHERMAL ENERGY COMPANY
KMERZ WELL NO. KA2-1
GEOTHERMAL EXPLORATION WELL PROGRAM

The following well program is designed to drill and complete a nominal 10,000′ geothermal exploration well in the KMERZ. (See Figure 001) Based on the results of prior drilling, a large degree of flexibility is built into the program. It should be clear that being an exploration well, the casing setting depths and drilling procedures are subject to change at any time. DLNR will be notified and updated as drilling progresses on any changes.

1. Install 30" conductor pipe in 42" hole to 60′ to 100′ or as deep as possible below ground level prior to rotary rig moving onto location. Cement conductor from total depth back to surface with redi-mix cement. If a burial cave or lava tube is encountered when setting the conductor pipe, further investigation is required prior to proceeding. Notify DLNR and consult with archaeologist. If conditions warrant, conductor installation may also be performed with rotary rig.

2. Construct 10′ x 10′ x 9′ deep cellar around conductor pipe with a cemented bottom and stairway exit toward front of rig. See attached Figure 002.

3. Move in rotary drilling rig to drill well. Center rig over conductor pipe and rig up. Drill 42" hole with bucket bit and install 30" conductor, if not installed prior to moving in. Add 30" OD extension to conductor pipe to bring it up under rotary table. Install flow line on conductor pipe to return mud to pits.

4. Notify DLNR upon startup of drilling of a pilot hole. Pick up an 8-1/2" bit on a 26" hole opener or reamer and run into the bottom of the conductor pipe. Center punch 8-1/2" hole and drill 8-10′. Pull out of hole and remove 26" hole opener or reamer. Run 8-1/2" bit and drill to 100′+/-. During the drilling of this 8-1/2" pilot hole progress should be monitored constantly to determine if a lava tube which may contain archaeological artifacts might be encountered directly under the rig. If the bit drops free for more than eight (8) feet then drilling will stop. If this drop occurs the hole will be flushed with clear water and a light source with video camera lowered into the hole to investigate the possibility of any archaeological value. If archaeological value is determined then drilling will stop and the rig moved. If no archaeological value is determined then provisions would be made to continue drilling. Drilling supervisor shall be on drill rig floor throughout complete pilot hole drilling operations.

5. Open 8-1/2" hole to 26" with 26" bit and drill with mud to 800-1000′ depending on geology. Maintain hole as straight as

possible, take drift shots every 100'. Maximum rate of change 1 degree per 100'. Install mud loggers at surface to log entire well from 0' to total depth. Catch three clean and dry samples every 10'.

6. Rig up and run 20" casing to total depth as per attached 20" casing program with 20" stab-in float collar and float shoe on bottom.

7. Once 20" casing has been run to bottom, run in hole with stab-in tool on bottom of drill pipe and stab into float collar. Circulate hole clean with at least two full circulations.

8. Cement 20" casing through drill pipe as per attached program. Circulate cement back to surface between 20" and 30" casing. Observe cement level. If cement falls back in annulus, bring same back to surface with 1" pipe.

9. Wait on cement 8 hours.

10. Land 20" casing. Cut off and remove 30" conductor drilling nipple. Cut off 20" casing and weld on 20" S.O.W. x 21-1/4" 2000 psi wellhead. Install two 3" valves and diverter. Install 20" blow out preventer equipment as per attached Figure 003.

11. Test 20" casing and blow out preventer equipment to 1000 psi for 30 minutes.

12. Drill out cement and float collar and float shoe from 20" casing with 17-1/2" bit using mud. Drill 30' of formation and trip to pick up stabilization.

13. Continue to drill 17-1/2" hole as vertical as possible with mud to 3500'+/- as indicated by formation. Directionally survey well at least every 100'. If lost circulation presents severe problems, an aerated mud system may be utilized. Severe loss circulation zones should be cemented off prior to drilling ahead.

14. Once 17-1/2" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

15. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

16. Rig up and run 13-3/8" casing as per attached 13-3/8" casing program and running procedure. If lost circulation presents severe problems during drilling it may be necessary to set 13-3/8" pipe as a liner then tie it back to the surface rather than a full string of casing. See running procedure for alternative options.

17. Cement 13-3/8" casing as per attached program. Circulate cement back to surface between 13-3/8" and 20" casings. Observe cement, if it falls back, bring level back to surface using 1" pipe.

18. Wait on cement 12 hours or until samples are set.

19. Land 13-3/8" casing. Remove 20" blow out preventer stack. Cut off 13-3/8" casing and install 12" x 21-1/4" 900 ANSI expansion spool wellhead with two 3" flanged outlets equipped with 3" 2000 psi wing valves. Install 12" 900 series blow out preventer stack with 12-1/4" bore as per attached Figure 004.

20. Test 13-3/8" blow out preventer stack to 1500 psi for 30 minutes.

21. Drill out all cement, float collar and shoe from the 13-3/8" casing with a 12-1/4" bit using mud. Drill 30' of formation and trip to pick up stabilization.

22. Drill 12-1/4" hole with mud or aerated mud as required by hole conditions to 6000-8000', the 9-5/8" casing point, as indicated by geologic staff. Lock up drilling assembly to maintain direction and angle as straight as possible to casing point.

23. Once 12-1/4" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

24. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

25. Rig up and run 9-5/8" casing as a liner equipped as required with external casing packer located 200-300' from bottom. Hang same using a double slip liner hanger with tie-back sleeve. Run 9-5/8" liner from total depth to hanger located 200' up inside of 13-3/8" casing as per attached 9-5/8" liner program and running procedure.

26. Once liner is hung, circulate hole clean through drill pipe with at least two full circulations.

27. Cement 9-5/8" liner and external casing packer from total depth back up to top of liner lap as per attached cementing program.

28. Once cement is in place, disengage from liner hanger and pull up 60' and circulate out excess cement.

29. Pull out of hole with liner hanging tool and run in hole with 12-1/4" bit and drill out cement from 13-3/8" casing to top of 9-5/8" liner lap. Test lap to 1000 psi only after cement has been in place 12 hours. Squeeze lap area if necessary to

obtain a 1000 psi squeeze pressure.

30. Trip for 8-1/2" bit and drill out excess cement from 9-5/8" liner down to top of float collar. Pressure up and retest 13-3/8" casing, liner lap and 9-5/8" casing to 1000 psi.

31. Drill out cement, float collar and float shoe from 9-5/8" casing using 8-1/2" bit and mud. Drill 30' of formation and circulate to change out mud for water. Re-install rotating head on blow out preventer stack for air drilling if not already installed for the drilling of the 12-1/4" hole.

32. Trip to pick up 8-1/2" stabilization. Drill 8-1/2" hole through production zone to total depth of 9,000'-12,000' using air or aerated water as a drilling medium.

33. Pull out of hole with drill pipe and test well for short term with rig on location.

34. If results appear commercial, pull out of hole and release rig for long production test or proceed ahead with attached 9-5/8" tie-back procedure to complete well with 9-5/8" tie-back, if 13-3/8" casing shows damage or excessive wear. If well test results prove that the flow rate from the well is not commercial then either deepen or redrill to obtain production.

35. Evaluate well and complete with either open hole or 7" slotted liner.

SPECIAL CONSIDERATIONS
AUXILIARY EQUIPMENT THAT SHOULD BE MAINTAINED WITH THE RIG

1. Six pen drilling recorders on drill floor with: a) string weight; b) rpm; c) rotary torque; d) rate of penetration; e) pump pressure; f) exit pressure. Additional real time monitoring of drilling parameters to be considered upon consultation with DLNR Staff.

2. Special rotating head with rubbers, capable of stripping 17-1/2", 12-1/4" and 8-1/2" bottomhole assemblies. Complete with spare rotating head stripper drive bushing assembly. Rotating head should be installed on top of hydril or at least on location, available for installation if necessary. Run cold water continuously on head while producing geothermal fluids.

3. Use tong torque assembly with torque gauge for making up collars to API torque requirements.

4. Temperature should be taken with every directional survey by running a maximum recording thermometer in the survey instrument.

5. Catch drill cutting samples (3 sets) every 10', to be cleaned and sacked.

6. In and out temperatures, both of mud, air or aerated water, shall be recorded in the Tour Reports every 30'. All steam/water entries shall be recorded in the Tour Reports.

7. All lost circulation zones encountered shall be recorded in Tour Book recording both the depth at which the loss occurred, as well as the amount of fluid lost. All flows shall also be recorded giving depth and the amount of increase.

8. Periodic tests may be conducted to determine well potential. Drilling will be stopped and the hole evacuated to check for flow at lost circulation zones.

9. Upon completion, the well will be shut in by closing the lower master valve. The remainder of the blow out preventer equipment will then be removed.

10. Rotary table will be equipped with a torque gauge with visual display for driller.

HYDROGEN SULFIDE MONITORING AND ABATEMENT

Hydrogen sulfide monitoring should be maintained during the drilling of the well. Detectors should be placed on the rig floor, cellar area, and flowline region to detect and announce (with alarms and lights) the presence of hydrogen

sulfide. These monitors are typically provided by and maintained daily by the geothermal data loggers. Proper functioning of these monitors is essential in maintaining a safe working environment.

Hydrogen sulfide abatement equipment and materials, i.e. pumps and caustic soda, should be maintained on location when drilling with lighter than water drilling fluids, i.e. air or aerated mud systems.

Escape breathing equipment, as well as resuscitators shall be available on site with mud logging unit. Fans should also be available on the rig floor to clear H2S contaminated floor areas, making it safer to work.

PIPE AND BLOW OUT PREVENTER INSPECTION

The initial acceptance of drill pipe should be based on an IODC-API Class II specification inspection. All subsequent inspections should discard pipe with 30% wear or greater; i.e., use 30% where Class II states 20%.

The drill pipe should include:

1. Electromagnetic inspection of tubes (Sonoscope or Scanalog).

2. Wall thickness and cross sectional area (ultrasonic or gamma ray).

3. End area inspection (electronic or magnetic particle).

All drill collar end areas should be magnetic particle inspected every 14 days or every 9 days while drilling with production or drilling with air or aerated mud systems.

All BOPs should be inspected for wear by the manufacturer or an authorized agent prior to installation. All BOPs should be tested after installation prior to drilling out cement.

Remind service companies furnishing bottomhole assemblies that their equipment should be magna-fluxed prior to delivery.

AIR EQUIPMENT REQUIREMENTS

Minimum air and pressure requirements are 4500 SCFM at 1000 psig for rotary drilling 12-1/4" hole below 13-3/8" casing.

Minimum air and pressure requirements are 3000 SCFM at 1000 psig for rotary drilling below 9-5/8" casing.

Hook-up lines, air meter, and scrubber, misting pump with minimum capacity of 10 gpm, and operating personnel will be furnished by the air contractor. Use Union Oil's UniSteam corrosion inhibitor while drilling in steam, to be injected into the drill pipe. The mixture for UniSteam is as follows:

Steam lbs/hr	Injection
0-20,000	5 gal UniSteam-10/BBl water
20,000-40,000	10-15 gal UniSteam-10/BBl water
40,000-150,000	20-35 gal UniSteam-10/BBl water
150,000+	40 gal UniSteam-10/BBl water

PROCEDURE FOR RUNNING AND CEMENTING 13-3/8" CASING

1. Drill to casing depth.

2. Circulate for 2-3 hours, two complete circulations to clean hole of cuttings.

3. Pick up excess drill pipe needed to stab into float collar for cementing the 13-3/8" casing.

4. Make short trip and circulate for 1-2 hours.

5. Pull out of hole and rig up to run 13-3/8" casing. Run multi-shot survey while pulling out of hole if necessary. If loss circulation has not been a severe problem in drilling the 17-1/2" hole, then proceed ahead to step 8 and run 13-3/8" casing as a full string. If loss circulation has presented problems, then proceed to step 23 and run 13-3/8" as a liner with tie-back string.

6. Run 13-3/8" casing grades, weights and thread design as indicated on attached detailed sheet with stab-in collar 40' from float shoe on bottom with centralizers located one in middle of bottom two joints and then one every other collar upward omitting any from the top 200'.

7. Set casing in elevators on spider. Do not set casing slips. Drop centralizing ring of 13-3/8" casing inside 20" wellhead. Install return hoses from 20" wellhead to mud pits.

8. Rig up with landing plate on top of 13-3/8" casing. Run drill pipe into 13-3/8" with stab-in sub on bottom. Stab into collar and rig up to circulate. Tie down drill pipe.

9. Circulate for 3 hours, or at least two full circulations, to clean up and cool down hole.

10. Rig up to cement.

11. If loss circulation is a problem, pump 20 BBls CaCl2 water, 10 BBls fresh water, 20 BBls sodium silicate, followed by 20 BBls viscous Geo-Gel mud spacer.

12. Pump cement without any additional spacers. Pump stage 1 consisting of Class G perlite blended 1:1 with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump this cement until you see returns of cement at the surface. If loss circulation has been a problem, the cement may have to be changed to a spherelite blended cement, see Note below.

13. Pump stage 2 cement: Class G cement with 40% silica flour, 3% gel and 0.5% CFR-2. Retard as needed. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu

ft and shut down again for 5-10 minutes before pumping last 30 cu ft. Check for fall back in annulus each time. Pull out of stab-in shoe and clear drill pipe, dropping all excess cement from drill pipe on top of float collar.

14. Rig down circulating equipment and pull out of hole with drill pipe.

15. Hook up to 13-3/8" casing elevators and pick up slightly to remove spider, then center 13-3/8" casing in stack.

16. Drain blow out preventer equipment after 30 minutes from the time cement was in place.

17. Wait on cement 12 hours before landing casing. Check for cement fall back in annulus periodically. Bring cement back to surface using 1" pipe if necessary.

18. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve and nipple up blow out preventer equipment as in attached Figure 004.

19. Test blow out preventer equipment to 1000 psi.

20. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

PROCEDURE FOR RUNNING & CEMENTING 13-3/8" AS A LINER AND TIE-BACK STRING

1. Follow steps 1-4 above.

2. Pick up 13-3/8" liner. If circulation was never achieved, then a stage collar should be installed at approximately 2000'. Install cement basket type centralizers in the middle of the bottom two joints and one just below stage collar. Install one cement basket type centralizer to be located 20' up inside 20" casing shoe.

3. Run liner in hole and hang same 100' up inside of 20" casing with shoe just off bottom.

4. Attempt to circulate with two times total volume of fresh water. If unsuccessful, then proceed with cement job.

5. Pump 20 BBls CaCl2 water and 10 BBls fresh water, followed by 20 BBls sodium silicate, 20 BBls Geo-Gel flush, then cement slurries for stage 1. Follow stage 1 cement with 200 cu ft of stage 2 cement.

6. Release plugs after stage 2 cement and open cementing ports if stage collar is run.

7. Circulate through stage collar. Repeat preflush prior to pumping cement. Pump stage 1 and stage 2 cement as in prior cement job on bottom section of 13-3/8" liner.

8. Release plugs and displace cement and plugs down hole to close stage collar.

9. Release hanger and pull out of hole with setting tool. Wait on cement for 6 hours.

10. Run in hole with 17-1/2" bit and clean out excess cement, if any, from the top of the 13-3/8" liner.

11. Test lap to 750 psi. If unable to get a test, trip to lay down bit, run in open ended. Squeeze lap with Class G cement blended with 40% silica flour and 0.5% CFR-2 using pipe rams.

12. Re-squeeze until a squeeze pressure is achieved. Fill hole with water.

13. Drill out excess cement with 17-1/2" bit and retest lap to 750 psi.

14. If successful in testing lap, run in hole with 12-1/4" bit and 13-3/8" casing scraper to clean out tie-back sleeve.

15. Pick up 13-3/8" tie-back with float collar located 40' above tie-back stinger on bottom.

16. Run tie-back string in hole and land same in sleeve at hanger.

17. Circulate around with fresh water, then run cement slurry. Use top plug only.

18. Wait on cement 6 hours. If after 6 hours cement is not to surface level in 13-3/8" x 20" annulus, insert 1" tubing and bring it back to surface with cement.

19. Cut off 13-3/8" casing. Remove 20" blow out preventer equipment. Install 21-1/4" x 12" 900 ANSI expansion spool, 12" master valve, and nipple up blow out preventer equipment as in attached Figure 004.

20. Test blow out preventer equipment to 1000 psi for 30 minutes.

21. Change out bottom hole drilling assembly for 12-1/4" tools and run in hole.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 5% lime, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 82.2#/cu ft (11 ppg). Slurry yield is 3.21 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

9-5/8" LINER RUNNING PROCEDURE

The drilling program for Well KA2-1 has been written in such a way as to handle all situations that occur during the drilling. Due to the remote location and shipping requirements we must consider all possible hole conditions. These conditions that should be anticipated are listed in order of increasing severity as follows:

1. The 12-1/4" hole is drilled with little or no loss circulation encountered. Due to lost circulation encountered in drilling it would be highly probable that loss of circulation may occur during the cementing of the 9-5/8" liner.
   In this situation where lost circulation has not presented a significant problem during drilling, I feel that a conventional method should be employed in the running and cementing procedure for the 9-5/8" liner. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER" should be used.

2. The 12-1/4" hole is drilled with air, aerated water or mud, with moderate loss circulation, that is loss circulation encountered in several zones which could be sealed with cement or LCM, or partial loss circulation zones which may take fluid periodically during drilling operations. Probability of lost circulation during cementing is high and should be anticipated.
   In this situation a certain amount of caution should be used in running and cementing the 9-5/8" liner to insure a competent cement job. A 9-5/8" liner utilizing a multi-stage cement collar strategically located could assist in obtaining an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER WITH MULTI-STAGE CEMENTER" should be used.

3. The 12-1/4" hole is drilled using air or aerated water because of complete loss of circulation during the drilling. Sealing of these loss circulation zones prove to be unsuccessful or extensive causing a great loss of time therefore air or aerated fluid is used to drill the well. Probability of loss circulation during the cement job is high, therefore extreme methods of cementing the liner should be used.
   In this situation where major problems exist in the well, extreme procedures and technologies should be employed to insure an adequate cement job. The attached program "PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER" should be used.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITHOUT EXTERNAL CASING PACKER AND MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000-7000′ dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60′ of the hanger. Use T-Bar rigid centralizers totally in bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600′, 1800′ and 3400′ above shoe joint if required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is encountered, pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours

pumping time at 350 degrees F. Use 100% excess. If lost circulation is a problem, cement may be required to be changed to a spherelite blend. See note at bottom of this procedure. Pump stage 1 as per precalculated volumes.

13. Pump stage 2: Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degrees F. Pump 200 cu ft of this stage 2 cement. The last 100 cu ft should be staged in: Pump 35 cu ft and shut down for 5-10 minutes, then pump 35 cu ft and shut down again for 5-10 minutes before pumping the last 30 cu ft.

14. Once all cement has been pumped then rig down circulating equipment, hang liner and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

15. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

16. Trip to change bits to 8-1/2" and clean out cement from inside of the 9-5/8" liner top.

17. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

18. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60' of formation with mud.

19. Circulate to clean hole and then displace mud in hole for water.

20. Trip out of hole to pick up stabilization.

21. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per cu ft (11.8 ppg). Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 53.5 ppf, Buttress, Burst: 6330 psi, Collapse: 3810 psi Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
WITH MULTI-STAGE CEMENTER

1. Drill to casing depth at approximately 6000 - 8000' dependent on temperature and geology.

2. Circulate for 2-3 hours to clean and cool hole.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and make short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of the bottom two joints and then one every to every other collar upward to within 60' of the hanger. Install multi-stage cementer in a strategic location in the liner string. The location of the multi-stage cementer should be such that the bottom portion can be cemented successfully without loss circulation. The upper portion can then be cemented after the bottom has had time to set without any loss circulation during cementing. A probable location is just above the loss circulation zones. If the hole was air drilled a good location would be approximately 1200' above the casing shoe. Use 12" T-bar rigid centralizers totally in the bottom portion of the string and then as required in the upper portion. Run casing adjusters at 600', 1800', and 3400' above shoe joint as required.

9. Circulate two full circulations to clean up and cool down well prior to cementing.

   Note: If casing can still be moved after running to bottom then move casing throughout circulation and cementing job and hang after stage 1 cement is in place. If casing will not move after running to bottom, then hang liner before circulating and cementing job.

10. If loss circulation is a problem then pump 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium

silicate.

11. Pump in 20 BBls of viscous Geo-Gel mud preflush.

12. Pump cement without any water spacers. Pump stage 1: Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 4-5 hours pumping time at 350 degrees F. Pump in calculated volume to fill the annulus of the 12-1/4" hole x 9-5/8" liner from the liner shoe to the stage collar with 100% excess, with approximately 200 cu ft of tail cement consisting of Class G cement blended with 40% silica flour, 3% gel and friction reducer. If loss circulation is a problem, cement may be changed to a spherelite blend. See note at the bottom of this procedure.

13. Pump stage 1 cement and drop dart for wiper plug. Displace cement with water. Bump plug and open multi-stage cementer.

14. After the stage collar has been opened then circulate out excess cement. Circulate and cool hole for 2 hours prior to pumping stage 2 cement. Hang liner at this point.

15. Pump in 20 BBls of CaCl2 water and 10 BBls of fresh water ahead of 20 BBls of sodium silicate.

16. Pump in 220 BBls of viscous Geo-Gel mud preflush.

17. Pump in stage 2 cement without any water spacers. Pump Class G cement and perlite blended at a ratio of 1:1 with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours pumping time at 350 degress F. Pump in calculated volume of cement to fill 12-1/4" hole x 9-5/8" liner to lap area without excess. Calculated volume should include a 200 cu ft tail slurry of Class G cement blended with 40% silica flour, 3% gel and friction reducer. Retard to give 2-3 hours of pumping time at 350 degrees F. Displace cement with water.

18. Once all cement has been pumped then rig down circulating equipment and pull out of liner hanger with drill pipe and pull up 90' and circulate out excess cement on top of liner top.

19. Wait on cement 12 hours. Run in hole with 12-1/4" bit to top of cement, drill out cement to liner top. Wait a full 24 hours from the time cement was in place or until samples have set before pressure testing lap to 1000 psi surface pressure. Squeeze lap if necessary to obtain a pressure test.

20. Trip to change bits to 8-1/2" and clean out cement from inside of 9-5/8" liner top.

21. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary to obtain a pressure test.

22. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 60′ of formation with mud or water.

23. Circulate to clean hole and then displace mud in hole for water if necessary.

24. Trip out of hole to pick up stabilization.

25. Run back in hole and aerate water. Drill ahead with aerated water to commercial production or total depth.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% friction reducer and fluid loss agent.

Cement should be mixed at 88.3 lbs per sack of cement. Slurry yield is 3.16 cu ft per sack of cement.

Mixing water requirements are 1.5 cu ft per sack (11.22 gal/sack).

9-5/8" CASING PROPERTIES

L-80, 47 ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5 ppf, Buttress, Burst 6330 psi, Collapse: 3810 psi, Tension: 1,038,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PROCEDURE FOR RUNNING AND CEMENTING 9-5/8" LINER
EQUIPPED WITH EXTERNAL CASING PACKER AND HYDRAULIC CEMENTER

1. Drill to casing depth at approximately 6000 - 8000' dependent on temperature and geology.

2. Circulate for 2-3 hours.

3. Pull out of hole.

4. Rig up and run logs as indicated by geologic staff. Wait on bottom with temperature log for 30 minutes before pulling out of hole.

5. Rig down loggers and run in hole with bit and monel to total depth.

6. Circulate for 2 hours and short trip. Circulate for 1-2 hours after short trip.

7. Pull out of hole and rig up to run 9-5/8" liner. Run additional directional surveys while pulling out of hole if necessary.

8. Run 9-5/8" liner grades, weights and thread design as indicated in attached detail sheet with float shoe on bottom and float collar two joints up. Centralizers should be located one in the middle of bottom two joints and then one every other collar upward to within 60' of hanger. Use T-Bar rigid centralizers in the bottom portion of the string and then as required in the upper portion. If lost circulation is a problem or the hole has been drilled with air or aerated water then CTC external casing packer should be positioned in string 200-300' from bottom with Halliburton hydraulic stage cementer located above packer. Run casing adjuster at 600', 1800', and 3400' from shoe joint as required. A T-Bar centralizer should be located above and below packer.

9. Run liner equipment. See attached Pre-Job Recommendations.

   Check all equipment to be run on 9-5/8" liner.
   a. Use Instructions & Operations Sheet TE 7.00381. Measure all parts OD and ID.
   b. Check threads on all tools.
   c. Midway liner hanger running tool. Stinger must be reduced down to 3" OD 2.75 ID and run 10-12.5" below bottom of liner hanger as shown on print TE 7.00378. This is when the liner hanger string is at the bottom of its travel.
   d. Part numbers are given on print TE 7.00377 for tools. ID and OD for SR Plug set is given on print TE 7.00379 OD and OD for HOS Cementer are given on print TE 7.00380.

e. All parts and number should check with prints.
f. HOS Tool has four shear pins that will take 2880 psi over Hydrostatic pressure to open it, two other pins are with the tool. Each pin adds 712.5 psi pressure to shear. Open pressure may be adjusted as needed.

10. Installing equipment onto casing strings. See attached Recommendations During Job for further details.

a. Guide shoe.
b. Centralizers on two joints.
c. Float collar.
d. Centralizers as per program.
e. Casing.
f. CTC Packers 200' off bottom.
g. One joint with centralizer in middle.
h. HOS Cementer.
i. Centralizers as per program - run casing adjusters located 1500' and 3000' from shoe.
j. Casing to top of liner. Fill liner as going in hole.
k. Make up SR Baffle Collar on bottom of liner hanger.*
l. Take O-ring off SR plug set and put on SR Baffle Collar.
m. Make up SR plug set on Baffle Collar and tighten at plug set to Baffle Collar. Be sure all parts are tight.
n. Circulate the liner at 3-4 BPM. Stop and circulate 2-3 times while running in hole with liner assembly on drill pipe.

*Be sure there are no areas of drill pipe on liner hanger less than 2.75 ID.

11. Cement liner in three stages.

a. Calculate volume of cement for bottom stage. (200 ft of 12-1/4" hole and 9-5/8" annulus plus shoe joint volume and volume to inflate CTC Packer).
b. Mix cement for above.
c. Pump cement for 200' annulus and shoe joint. Release first stage dart 809.81266 and pump cement for inflated CTC. (Cement to inflate packer should be Class G with 40% silica flour and friction reducer, no perlite.)
d. Pump 10 BBls spacer then displace with mud at 3-4 BPM until 10 BBls before dart should land in SR lower plug - slow rate to 2 BPM. Pressure should go to 1800 psi and plug release.
e. Displace shut off plug at 5-6 BPM until 30 BBls before plug lands. Then pump at 1-2 BPM.

f. When shut off plug lands in shut off baffle, pressure up to 500 psi and shut down.

12. Inflate CTC Packer with cement. See attached Recommendations During Inflation Sequence for further details.

    a. Check volume of displacement tank.
    b. Increase pressure slowly to 700 psi and shut down.
    c. Increase pressure slowly to 800 psi.
    d. Increase pressure slowly to 900 psi or until tool opens.
    e. Pump in 2-5 cu ft of cement per stage until CTC packer is inflated.
    f. Increase pressure to 1000 psi to close CTC packer.
    g. With pressure at 500 psi, check volume of cement needed to inflate tools.
    h. Pressure up to 2800 psi and open HOS.
    i. Circulate well as needed.
    j. Cement liner as per program. Pump spacer. Pump cement.
    k. Release dart for shut off plug. Pump at 4-5 BPM. Pump 10 BBls spacer - then mud.
    l. Displace to within 10 BBls of plug, slow to 2 BPM.
    m. Pressure to 1950-2000 psi to release plug.
    n. Displace at 4-5 BPM.
    o. When plug lands in HOS, pressure up to 3000 psi to close tool. You may have to go to 3500 psi. Hold pressure for 2 minutes.
    p. Release pressure if holding; back off liner hanger tool.
    q. Come out of hole with tools.
    r. Wait 24 hrs and drill out.

13. Rig down circulating equipment, pull out of hanger with drill pipe and pull up 90' and circulate out excess cement leaving 90 linear ft of cement on top of liner top.

14. Wait on cement for 12 hrs. Run in hole with 12-1/4" bit to top of liner and circulate to clean out excess cement. Wait 24 hrs from the time cement was in place and pressure test lap to 1000 psi. Squeeze if necessary.

15. Trip to change bits to 8-1/2" and clean out cement from inside the 9-5/8" liner top.

16. Retest liner lap to 1000 psi surface pressure. Squeeze if necessary.

17. Drill out cement, float collar and float shoe with 8-1/2" bit. Drill 30' of formation.

18. Circulate and change out mud system for water.

19. Trip to pick up stabilization.

NOTE: Spherelite cement should be blended as follows:

Class G cement blended with 40% silica flour, 50 lbs per sack of cement of spherelite, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A.

Cement should be mixed at 88.3lbs/cu ft (11.8 ppg). Slurry yield is 3.16 cu ft/sack.

Mixing water requirements are 1.50 cu ft/sack (11.22 gal/sack).

CASING PROPERTIES

L-80, 47ppf, Buttress, Burst: 6870 psi, Collapse: 4760 psi, Tension: 1,122,000 lbs.

L-80, 43.5ppf, Buttress, Burst: 7930 psi, Collapse: 6620 psi, Tension: 1,286,000 lbs.

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

PRE-JOB RECOMMENDATIONS

1. In close clearance (1/2"-1") installations:

    a. Run a casing scraper.
    b. Drill open hole section with a stabilized packed hole assembly if possible.

2. In liner installations, notify CTC of type of liner equipment before packers are shipped.

3. Insure that everyone involved understands the Payzone Packer system and specific duties they are to perform.

4. Obtain all pertinent well data, including:

    a. Minimum wellbore restriction (should be 1/2" greater than packer OD).
    b. If casing damage is suspected, run a microscopic caliper and/or casing scraper.
    c. Calipered hole size in zone of interest should not exceed maximum recommended hole size. Use "Hole Size vs. Recommended Inflation Pressure Chart" to set pressure control valve.
    d. If junk has been lost in hole it should be fished or driven to below Payzone setting depth.
    e. Clients maximum allowable surface pressure (burst strength of casing with a safety factor), should be obtained prior to setting shear pin.
    f. If hole size adjacent to end assemblies is more than 1" larger than packer OD run one centralizer above and below each packer.

5. Inspect auxiliary equipment.

    a. Float shoe.
    b. Float collar.
    c. Bottom cement wiper plug (proper size, rupture diaphragm).
    d. Two top cement wiper plugs (proper size, no rupture diaphragm).
    e. Pressure recorder (5000 psi scale if possible).
    f. Chicksan lines.
    g. Cementing head.
    h. Verify that adequate inflation cement is available.
    i. Obtain a dry sample of all cements used on the job.

6. Review primary cementing plans and calculate theoretical bottom hole pressure during cementing operations. If expected pressures approach fracture gradient, pressure anomalies are probable and bottom wiper plug should not be run so that knockoff rod protection stays intact.

7. Calculate displacement volumes. Know at what displacement the following events should take place:

    a. Bottom wiper passes packers (knockoff rods).
    b. Bottom wiper lands in float collar.
    c. First top wiper passes packer.
    d. First top wiper lands in float collar, and
    e. Top of inflation cement (second top wiper plug) relative to upper packer.

8. Total inflation pressure is critical to Payzone Packer performance. Before starting a job know and/or calculate: 1. hydrostatic pressure inside and outside the casing at packer setting depth, 2. pore pressure, 3. fracture pressure, 4. maximum recommended differential inflation pressure from hole size vs pressure chart, 5. resultant effective stress.

    a. Total inflation pressure equals:
        1. Hydrostatic pressure inside casing (packer depth) + Applied surface pressure

        OR

        2. Hydrostatic pressure outside casing (packer depth) + Differential inflation pressure

    b. Differential inflation pressure equals:
        1. Total inflation pressure minus Pressure outside casing (packer depth)

        OR

        2. Applied surface pressure minus Balance pressure

    c. Balance pressure equals:
        1. Surface pressure required to offset "U" tube pressure
        2. Approximated by surface pressure (pumping at 1/4-1/2 BBl/min) just prior to plug bump.

    d. Radial effective stress (Seal Load, Wellbore Support) equals:
    Total inflation pressure minus pore pressure.
    -In all cases the differential inflation pressure must be within the hole size vs differential pressure capabilities of the equipment.
    -For zone isolation the radial effective stress (seal load) should be at least 500 psi and total inflation pressure must be less than fracture pressure.

9. Review casing tally. Re-tally casing during run-in if necessary. This is critical if positioning log is not to be run.

10. Make up casing according to API specifications with proper torque and API pipe dope.

Note: It is extremely difficult to properly inflate packers with a casing leak.

11. Epoxy thread lock should be used on packer/casing connections, float collar, and float shoe.

12. A minimum number of only high quality (API approved) centralizers be run below packer(s). If pipe is to be reciprocated, and hole size adjacent to end assemblies does not exceed packer OD plus 2", spacing between packers and centralizers should be greater than reciprocation stroke. Do not place scratchers in this area.

13. If positioning is critical, packers should be logged into position.

14. Insure that cement has adequate pump time.

15. Inflation cement should have an API water loss of less than 150 cc. Inflation cement must not contain lost circulation material.

RECOMMENDATIONS DURING JOB

1. Verify that external cementing aids (centralizers, scratchers, etc.) are properly installed.

2. Run-in speed 1 ft/sec (may be prudently increased to 2 ft/sec per Steps 3 and 4 below).

3. Monitor returns, if more than 30' of casing is run before receiving full returns - SLOW DOWN.

4. Monitor weight indicator - excessive weight loss during run indicates that run-in speed may be too fast.

5. Pressure test lines before beginning cement job. Repair all leaks no matter how small.

6. Verify that wiper plugs are dropped at proper time in proper sequence.

7. Monitor returns during entire job.

8. Monitor mixing and pumping of inflation cement. Verify volume and weight of inflation cement. Batch mix if possible.

   Note: If inflation cement is not batch mixed, monitor BBl counter, but do not rely on its accuracy. Insist that mix water be accurately measured from tanks and that cement density remains constant and proper. (If cement is mixed at proper weight, mix water volume is an accurate indicator of cement volume.)

9. Insist that plug drop be verified via tattle-tale, flag or radioactive techniques.

10. Monitor displacement volume, pump rate and surface pressure during entire displacement process.

11. Determine balance pressure during last 5 BBl of displacement. (Slow displacement to 1/4-1/2 BBl/min and record pressure.)

12. Required displacement volume will normally exceed theoretical casing volume. If mud is used for displacement, expect up to 6%.

RECOMMENDATIONS DURING INFLATION SEQUENCE

1. When first plug lands in float collar:

2. Open shear valve in first or bottom packer by rapidly applying appropriate surface pressure, i.e. balance pressure plus pressure rating of shear valve. (Monitor volume displaced.) Stop pumps and monitor pressure decline, increase pressure by 200 psi or as needed to open valve. Record volume in displacement tanks.

   NOTES:

   a. Flow rate into Payzone packers is relatively slow (1/4 BBl/min). Therefore, it is generally impractical and not advisable to pump continuously during inflation. The preferred procedure is to rapidly increase surface pressure, stop pumping and monitor pressure decline. When the packer is full, the pressure decline will stop.

   b. The expected pressure response during inflation is a function of several variables. In general the following reduce the distinctiveness of the pressure response.
      1. Increased well depth.
      2. Compressability and volume of fluid within the casing string.
      3. Large diameter casing.
      4. Viscosity of inflation cement.
      5. Small inflation volume.

      For example, the pressure response during inflation of a 9-5/8" packer at 12,000' with 3/4 BBl of 16.4 lbs/gal cement may be non-distinct while inflation of a 5-1/2" packer with 1 BBl at 6000' would be very distinct.

3. When packer is completely inflated (surface pressure remains constant), apply final desired inflation pressure.

   a. Record volume pumped and hold pressure for 5-10 min.

   b. Bleed surface pressure slowly back to balance pressure (and/or point 1a above and record flowback volume.

   c. Release pressure slowly.

Note: In shallow (less than 7000') unconsolidated sands, the hole size often enlarges as the packer re-stresses the sand. In these installations, final inflation pressure should be adjusted or reduced in accordance with hole size.

This may be done by converting inflation volume to equivalent hole diameter and using "Hole Size vs Recommended Inflation Pressure Chart".

THINGS TO AVOID

1. Avoid using bottom wiper plugs whenever possible. This is critical if bottomhole pressures during the cement operation are likely to exceed frac pressure.

2. Avoid using spacer fluids below inflation cement because volumetric error and/or pressure anomalies may result in mud-filled packers.

   Note: The use of lightweight spacer fluids below the inflation cement imposes a hydrostatic differential pressure across the valve collar equal to [Weight of cement in annulus (lbs/gal) minus weight of spacer fluid below packer (lbs/gal)] multiplied by .052 times height of spacer fluid below packer.

3. Do not exceed fracture pressure in isolation installations.

4. If spacer fluids are used as substitues for wiper plugs above inflation cement, increase cement volume to compensate for contamination of the upper 100′ of inflation cement.

5. Do not use differential fill equipment because debris may enter casing. Some varieties of differential fill equipment must be opened via applied casing pressure prior to circulation. This is not compatible with our valve system.

6. Insist that liner hanger packoffs not be set prior to packer inflation.

7. Do not spud casing - circulate through bridges.

8. Do not use cement with more than 6% Plaster of Paris or Calseal cement.

9. Do not use loss circulation material in inflation cement.

PROCEDURE FOR RUNNING 9-5/8" TIE-BACK CASING
OPTIONAL

1. Kill well with cold water. Pick up Halliburton 9-5/8" EZSV cement retainer on drill pipe and run in hole to 300' below liner top. Set EZSV at this point.

2. Spot a 50 linear foot thick viscous gel pill on top of EZSV and 50 linear feet of cement on top of gel. Fill hole with water and circulate to cool and clean hole. Make appropriate changes to wellhead assembly.

3. Run 9-5/8" casing scraper to clean out liner tie-back sleeve.

4. Rig up and run 9-5/8" tie-back string to top of liner with float collar 40' (1 joint) above stab-in tool on bottom. Stab-in tool will be equipped with slip. Stab into liner, engage slips on the 13-3/8" and pull up on tie-back to 200,000 lbs to pretension tie-back.

5. Cement tie-back as per attached cementing program. Bring cement back to surface between 9-5/8" and 13-3/8" casing, setting centralizer in 13-3/8" casing head before cementing.

6. Wait on cement 12 hours, then release tension.

7. Land 9-5/8" casing. Pick up 12" blow out preventer stack and install expansion spool (12" 900 x 10" 900) equipped with two 3" flanged outlets with 3" 2000 psi wing valves. Install 10" 900 Master Valve and 10" 900 x 12" 1500 adaptor spool and reinstall blow out preventer stack.

8. Test blow out preventer stack, 10" master valve, expansion spool and 9-5/8" tie-back to 1500 psi.

9. Pick up 8-1/2" bit and drill out excess cement and float collar. Work bit through lap area and retest to 1000 psi. Squeeze if necessary.

10. Drill out cement and clean out gel to top of EZSV.

11. Trip for EZSV picking tool and remove EZSV.

12. Return well to production and retest if necessary, using air to induce well to flow.

13. Lay down drill pipe, remove blow out preventer equipment,and move rig off, releasing rig.

14. Prepare for long term test.

15. Test well.

9-5/8" CASING PROPERTIES

L-80, 40 ppf, Buttress, Burst: 5750 psi, Collapse: 3090 psi, Tension: 947,000 lbs.

FIGURES

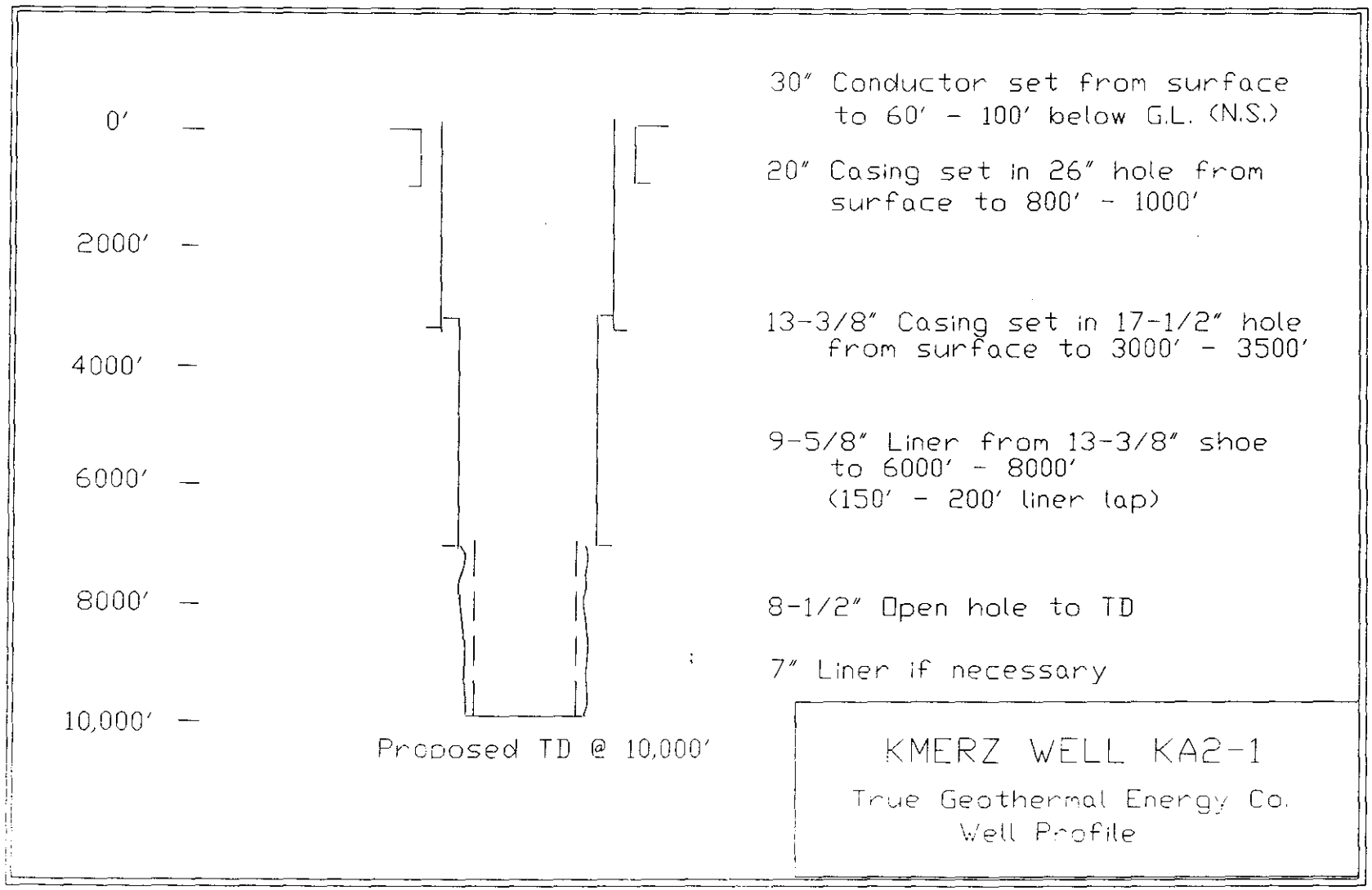

0'
2000'
4000'
6000'
8000'
10,000'
Proposed TD @ 10,000'
30" Conductor set from surface to 60' - 100' below G.L. (N.S.)
20" Casing set in 26" hole from surface to 800' - 1000'
13-3/8" Casing set in 17-1/2" hole from surface to 3000' - 3500'
9-5/8" Liner from 13-3/8" shoe to 6000' - 8000' (150' - 200' liner lap)
8-1/2" Open hole to TD
7" Liner if necessary
KMERZ WELL KA2-1
True Geothermal Energy Co.
Well Profile

FIGURE 001

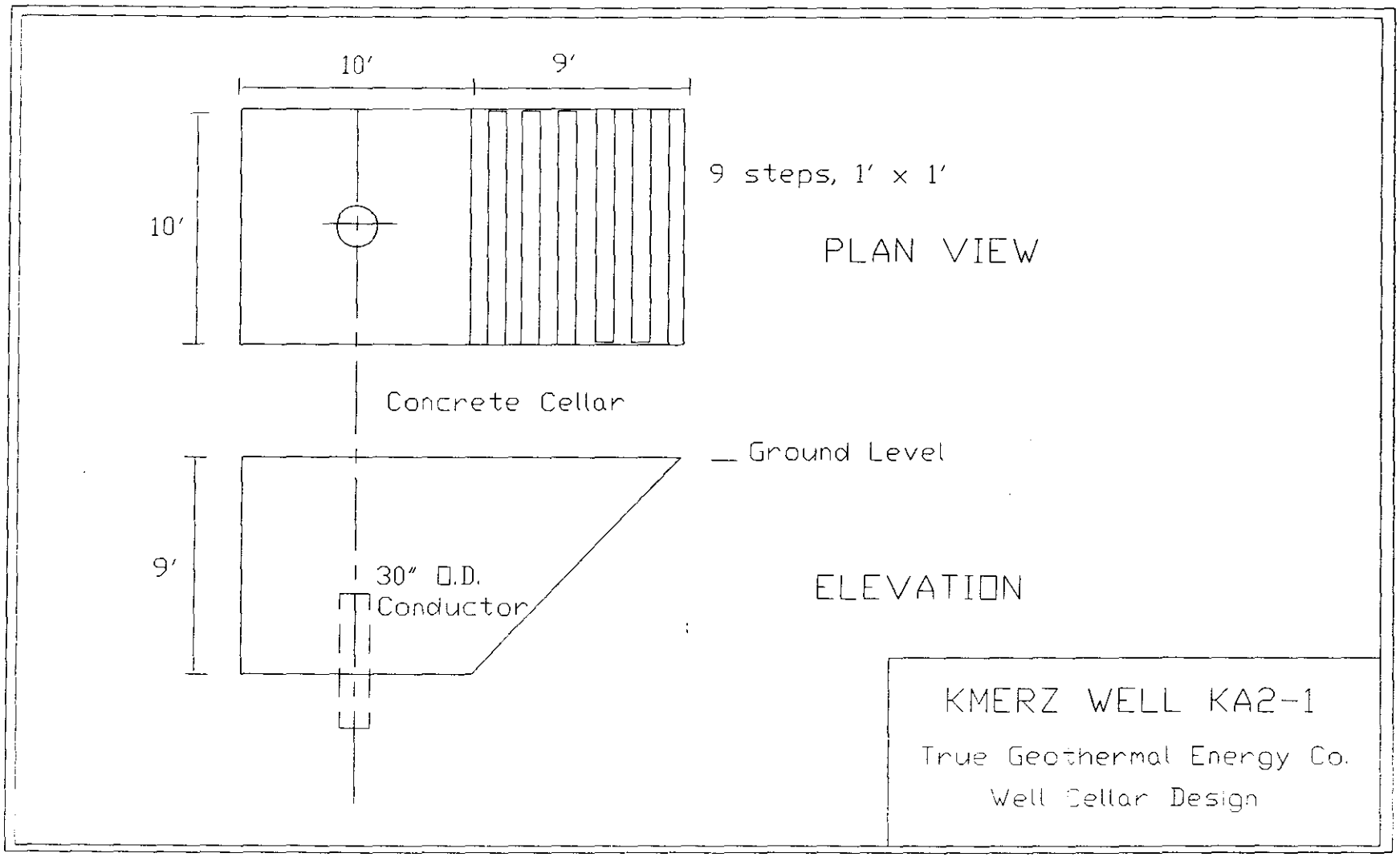

10'
9'
10'
9 steps, 1' x 1'
PLAN VIEW
Concrete Cellar
Ground Level
9'
30" O.D.
Conductor
ELEVATION
KMERZ WELL KA2-1
True Geothermal Energy Co.
Well Cellar Design

FIGURE 002

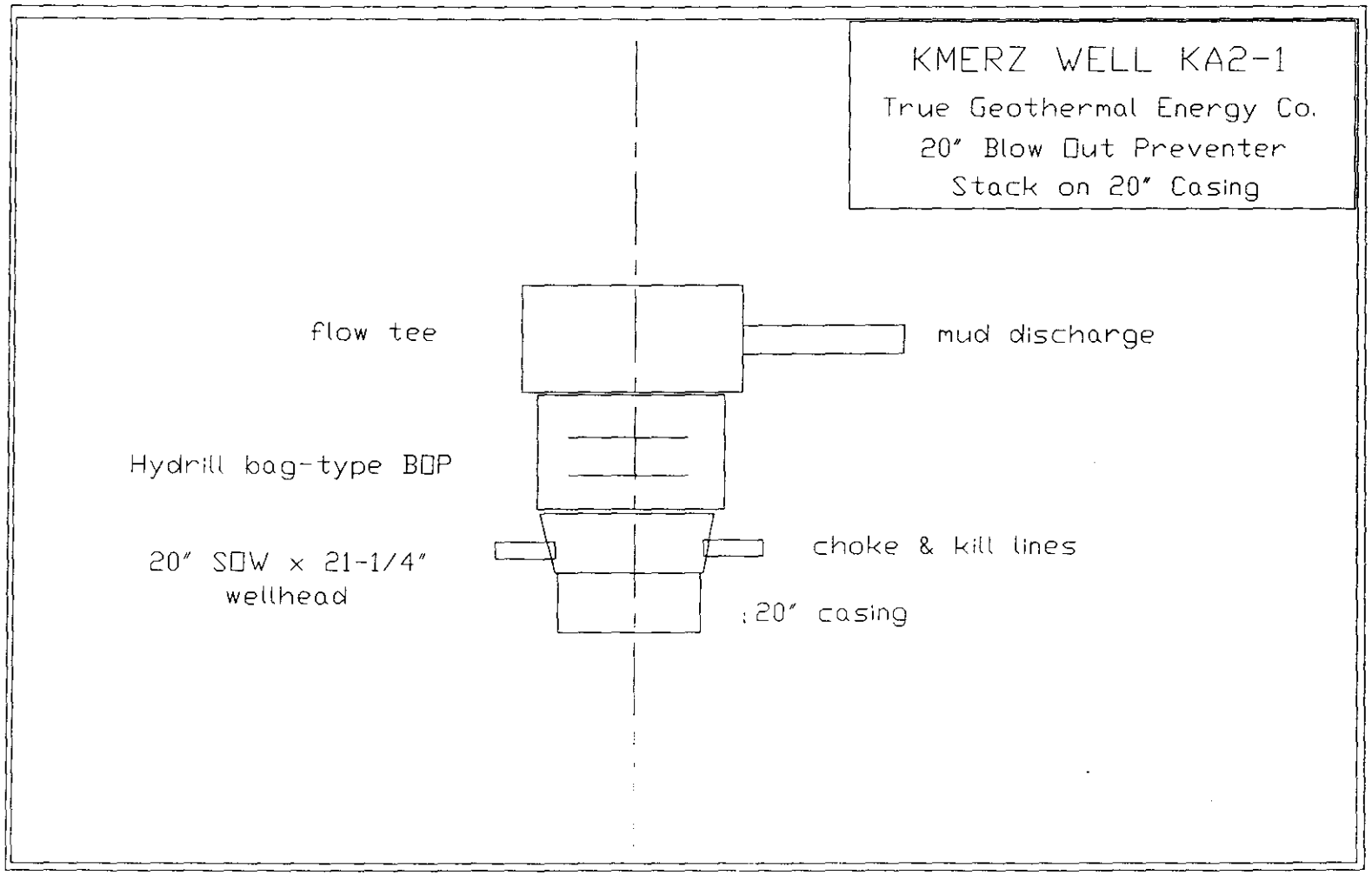

KMERZ WELL KA2-1
True Geothermal Energy Co.
20" Blow Out Preventer
Stack on 20" Casing
flow tee
mud discharge
Hydrill bag-type BOP
20" SOW x 21-1/4"
wellhead
choke & kill lines
20" casing

FIGURE 003

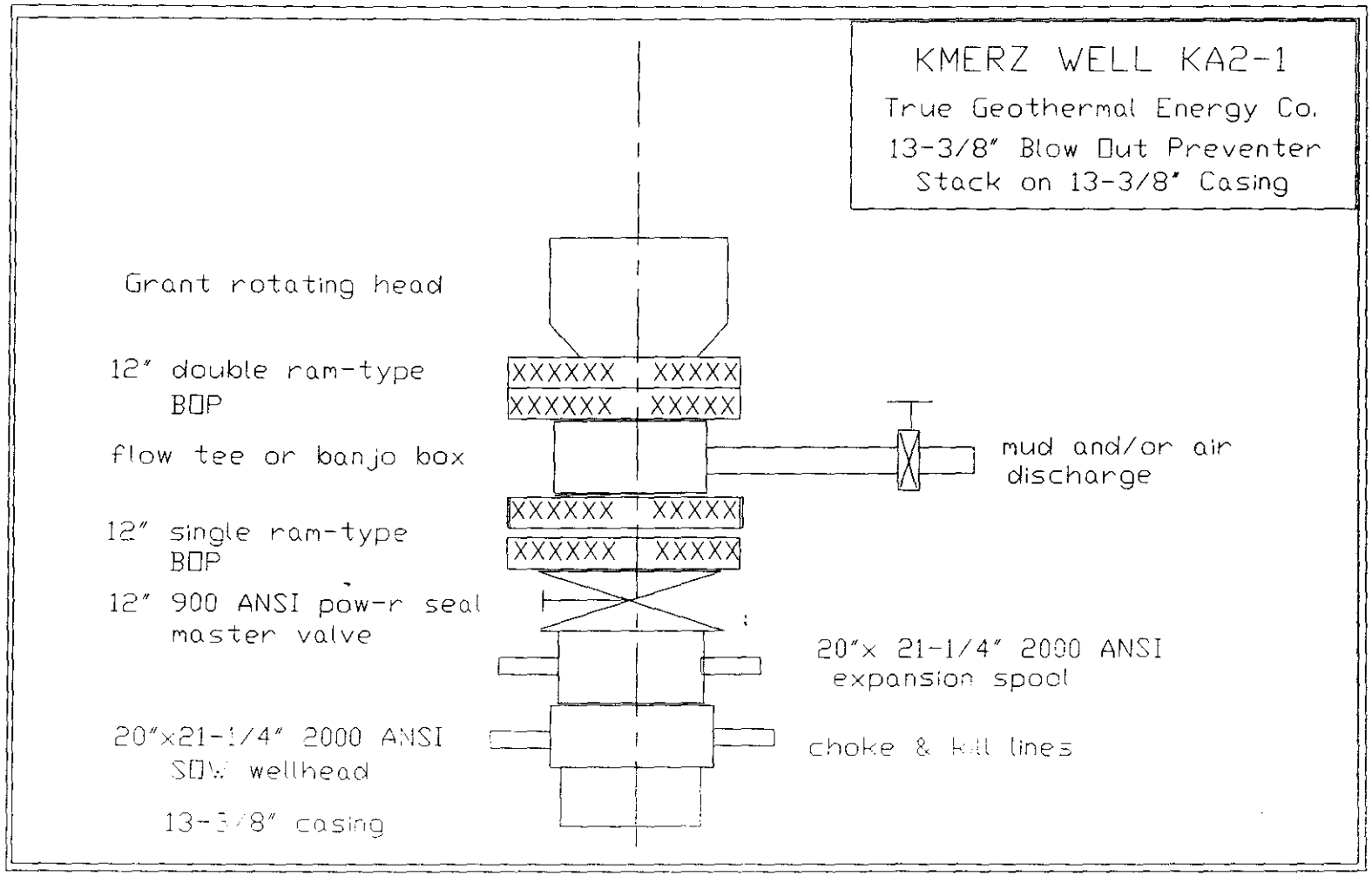

KMERZ WELL KA2-1
True Geothermal Energy Co.
13-3/8" Blow Out Preventer
Stack on 13-3/8" Casing
Grant rotating head
12" double ram-type BOP
flow tee or banjo box
12" single ram-type BOP
12" 900 ANSI pow-r seal master valve
20"x21-1/4" 2000 ANSI SOW wellhead
13-3/8" casing
mud and/or air discharge
20"x 21-1/4" 2000 ANSI expansion spool
choke & kill lines

FIGURE 004

TABLES

ThermaSource Inc.
P.O. Box 1236 · Santa Rosa, CA 95402

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE	DEPTH	WELL
20"	1000'	KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-1000'	106.5	K-55	Buttress	3.31	9.21	1.64	9.99+
Casing Properties:							
Collapse-770 psi							
Burst-2320 psi							
Tension-1,683,000 lbs.							

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 2000 PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.95 PPG		
INSIDE MUD WEIGHT (BURST)	- 9.5 PPG	INSIDE MUD WT. (COLLAPSE)	- 0 PPG		
OUTSIDE MUD WEIGHT (BURST)	- 9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5 PPG		
FRAC. GRAD. AT SHOE (BURST)	- 14.5 PPG	BIAXIAL LOAD: COLL. ☐ BURST ☐		BOUYANCY: YES ☐ NO ☒	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

2690 cu ft (838 sx) of Class G cement blended with 50 lbs of spherelite per sack of cement, 40% silica flour, 4% gel, 5% hydrated lime, 1.25% CFR-2 and 0.5% Halad-22A tailed with 400 cu ft (252 sx) of Class G cement blended with 40% silica flour and 3% CaCl2

			DESIRED TOP	EXCESS
			Surface	100%
SLURRY VOL. - CU FT / (SLURRY NO.)	2690		400	
SLURRY YIELD - CUBIC FEET/SACK	3.21 cu ft/sx		1.59 cu ft/sx	
SLURRY DENSITY - PPG	82.2#/cu ft(11 ppg)		118#/cu ft(15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLARS AND JOINT STRENGTHENING

1. Stab in float collar located 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 2 joints, then one every other tool joint to within 100' of surface.
2. Use centralizer cement baskets as required due to lost circulation.

REFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Stab into float collar with drill pipe. Attempt to circulate with water.
2. Pump 200 cu ft CaCl2 water followed by 100 cu ft of fresh water, 200 cu ft Flo-chek, 200 cu ft Geo-gel, then cement slurries.

PRESSURE TESTING AND LANDING

1. Use 1" pipe in annulus of 20" AND 26" hole to bring cement back to surface if necessary.
2. Wait on cement 8 hours.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	2000	20"	See attached drawing	1500	1500	

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM

SIZE: 13-3/8" | DEPTH: 3500' | Full String | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS: TOP BURST	BOT. BURST	COLL.	TENSION
0-3000'*	68	L-80	Buttress	2.03	1.95	1.51	6.44
3000-3500'**	72	L-80	Buttress	2.08	2.05	1.55	45.83
Casing Properties:*				Casing Propertires:**			
Collapse-2260 psi				Collapse-2670 psi			
Burst-5020 psi				Burst-5380 psi			
Tension-1,545,000 lbs				Tension-1,650,000 lbs			

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	-	9.5 PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE)	-	0 PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	-	9.5 PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

4257 cu ft (1723 sx) Class G cemetn blended 1:1 with perlite and 40% silica flour, 4% gel and 0.65% CRF-2. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hours pumping time at reservoir temperature.

DESIRED TOP: Surface | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	4257		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft(13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLARIS! AND JOINT STRENGTHENING

1. Run stab in float collar 40' (1 joint) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on float collar and shoe as well as bottom 4 joints.
4. Tac-weld top of collars on bottom 2 joints.
5. Run 13-3/8" as full string or liner with tie-back as hole conditions dictate. See attached procedure.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom 8 joints. Then turbo-type centralizer on every other collar from bottom to within 200' of surface.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. If lost circulation is a problem run casing as directed in attached procedure. Use sodium silicate preflush as directoed.
2. Cement through drill pipe.
3. Pump cement of Stage 1 until cement appears at surface, then pump stage 2 cement.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs or until samples have set.
2. Cut & remove 20" casing. Install 12" x 20" expansion spool and blow out preventer stack as in attached drawing.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI: RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	Rotating head & ram	1500	1500	1000

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM | SIZE: 13-3/8" | DEPTH: 3500'± | Liner | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
900-3000'	68	L-80	Buttress	2.01	1.95	1.49	8.68
3000-3500'	72	L-80	Buttress	2.07	2.05	1.53	45.83

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.5 PPG		
INSIDE MUD WEIGHT (BURST)	- 9.5 PPG	INSIDE MUD WT. (COLLAPSE)	- 0 PPG		
OUTSIDE MUD WEIGHT (BURST)	- 9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5 PPG		
FRAC. GRAD. AT SHOE (BURST)	- 14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]		BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

3340 cu ft (1041 sx) Class G cement blended with 50# per sack of cement of spherelite, 40% silica flour, 5% hydrated lime, 4% gel, 1.25% CFR-2, and 0.5% Halad-22A, tailed with 300 cu ft (189 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries retarded to give 2-3 hrs pumping time at reservoir temperature. DESIRED TOP: 900'± EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	3340	300		
SLURRY YIELD - CUBIC FEET/SACK	3.21	1.59		
SLURRY DENSITY - PPG	82.2	118		
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs	2-3 hrs		
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above float shoe.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints.
4. Tac-weld top of collars on last 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

3. Hang liner 100' up inside 20" casing on drill pipe.
4. Run rigid centralizer cement baskets in middle of bottom 2 joints and one 10' up inside 20" casing and one just below stage collar if a stage is indicated.
5. Run centralizers every other tool joint to bottome of 20" casing.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump 20 cu ft CaCl2 water and 100 cu ft water, followed by 200 cu ft Flo-Chek the 200 cu ft of Geo-gel, then cement slurries.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

Wait on cement 8 hrs. Clean out cement from top of 13-3/8" liner. Test lap to 1000 psi. Squeeze lap if necessary. Clean out and retest until a test is obtaned.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
		No change until tie-back run				

CASING, CEMENTING AND BOP PROGRAMS

ASING PROGRAM — SIZE: 13-3/8" | DEPTH: 900'± | Tie-Back | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-900'	68	K-55	Buttress	1.76	1.67	5.04	25.25

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE) -	9.5	PPG
SIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE) -	0	PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE) -	9.5	PPG
RAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1059.8 cu ft (666 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

	DESIRED TOP	EXCESS
	Surface	30%

SLURRY VOL. - CU FT / (SLURRY NO.)	1059.8			
SLURRY YIELD - CUBIC FEET/SACK	1.59			
SLURRY DENSITY - PPG	118			
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run rigid centralizer in middle of bottom joint and one every other tool joint to surface except for top 100'.

PREFLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

. Wait on cement 6 hrs before landing and cutting off 13-3/8" for wellhead.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	3000	12-3/8"	See attached drawing	1500	1500	

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM — SIZE: 9-5/8" | DEPTH: 7000' | Liner | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
3300--5300'	40	L--80	Buttress	2.04	1.97	1.08	6.08
5300--6500'	43.5	L--80	Buttress	2.17	2.30	1.16	13.71
6500--7000'	47	L--80	Buttress	2.30	2.29	1.36	47.74

DESIGN CONDITIONS

SURFACE BURST PRESSURE	-	3000 PSI	OUTSIDE MUD WT. (COLLAPSE)	-	9.5 PPG
INSIDE MUD WEIGHT (BURST)	-	9.5 PPG	INSIDE MUD WT. (COLLAPSE)	-	0 PPG
OUTSIDE MUD WEIGHT (BURST)	-	9.5 PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	-	9.5 PPG
FRAC. GRAD. AT SHOE (BURST)	-	14.5 PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION AND NUMBER

2000 cu ft (810 sx) of Class G cement blended 1:1 with perlite and 40% silica flour, 4% gel, and 0.65% friction reducer. Tailed with 300 cu ft (192 sx) of Class G cement blended with 40% silica flour and friction reducer. Both slurries to be blended with retardant to give 2-3 hrs pumping time at reservoir temperature.

DESIRED TOP: To liner top | EXCESS: 100%

SLURRY VOL. - CU FT / (SLURRY NO.)	2000		300	
SLURRY YIELD - CUBIC FEET/SACK	2.47		1.56	
SLURRY DENSITY - PPG	97.25#/cu ft (13.0 ppg)		118#/cu ft (15.8 ppg)	
THICKENING TIME - DEPTH SCH/HRS. MIN.	2-3 hrs		2-3 hrs	
COMPRESSIVE STRENGTH - PSI/HOURS				

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 80' (2 joints) above float shoe on bottom.
2. Weld bottom of collars on bottom 4 joints.
3. Clean and Baker loc threads on bottom 4 joints as well as threads on float collar and shoe.
4. Tac weld top of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Hand liner 200' up inside 13-3/8" casing with drill pipe.
2. Run rigid centralizers in middle of bottom 4 jonts and then 1 turbo type centralizer every collar to within 200' of top.
3. Run stage collars and external casing packer as in attached procedures.

PUMP FLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Attempt to circulate with water.
2. Pump cement and preflush as in attached procedures.

PRESSURE TESTING AND LANDING

1. Wait on cement 12 hrs. Clean out cement from top of 9-5/8" liner. Test lap to 1000 psi. Squeeze lap if necessary to obtain good pressure test.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
		No change until tie-back run				

CASING, CEMENTING AND BOP PROGRAMS

CASING PROGRAM — SIZE: 9-5/8" | DEPTH: 3300'± | Tie-Back | WELL: KA2-1

INTERVAL	WEIGHT LB/FT	GRADE	JOINT TYPE	CALCULATED SAFETY FACTORS			
				TOP BURST	BOT. BURST	COLL.	TENSION
0-3300'	40	L-80	Buttress	2.10	1.92	2.34	7.17

DESIGN CONDITIONS

SURFACE BURST PRESSURE	- 3000	PSI	OUTSIDE MUD WT. (COLLAPSE)	- 9.5	PPG
INSIDE MUD WEIGHT (BURST)	- 9.5	PPG	INSIDE MUD WT. (COLLAPSE)	- 0	PPG
OUTSIDE MUD WEIGHT (BURST)	- 9.5	PPG	FORM. PRESS. GRAD. AT SHOE (COLLAPSE)	- 9.5	PPG
FRAC. GRAD. AT SHOE (BURST)	- 14.5	PPG	BIAXIAL LOAD: COLL. [X] BURST [X]	BOUYANCY: YES [ ] NO [X]	

CEMENTING PROGRAM

SLURRY DESCRIPTION AND PROPERTIES

SLURRY DESCRIPTION (AND NUMBER)

1140 cu ft (704 sx) Class G cement blended with 40% silica flour and 0.5% CFR-2.

	DESIRED TOP	EXCESS
	Surface	30%

SLURRY VOL. - CU FT / (SLURRY NO.)	1140			
SLURRY YIELD - CUBIC FEET/SACK	1.62			
SLURRY DENSITY - PPG	116			
THICKENING TIME - DEPTH SCH/HRS, MIN.	2-3 hrs			
COMPRESSIVE STRENGTH - PSI/HOURS	±2323/8 hrs			

RUNNING AND CEMENTING INSTRUCTIONS

SHOE, COLLAR(S) AND JOINT STRENGTHENING

1. Run float collar 40' above tie-back sleeve on bottom.
2. Clean and Baker loc threads on bottom 4 joints.
3. Tac-weld top and bottom of collars on bottom 2 joints.

CENTRALIZERS AND SCRATCHERS - NUMBER, TYPE AND SPACING

1. Run centralizers in middle of bottom joint and one every other tool joint to surface except for top 100'.

FLUSH, DISPLACEMENT RATE, PLUGS, RECIPROCATION, ETC.

1. Circulate with fresh water.
2. Run top plug only.
3. See attached program for more detail.

PRESSURE TESTING AND LANDING

1. Wait on cement 6 hrs before landing and cutting off 9-5/8" for expansion spool and blow out preventers.

BOP PROGRAM

API STACK ARRANGEMENT CODE	WORKING PRESSURE PSI	MINIMUM BORE INCHES	TYPE	TEST PRESSURES - PSI		
				RAM TYPE	ANNULAR TYPE	ROTATING HEAD
	1500	8-1/2"	See attached drawing	1500	1500	1000

ThermaSource Inc.
P.O. Box 1236 • Santa Rosa, CA 95402

MUD

MUD, LOGGING, WELLHEAD & DIRECTIONAL PROGRAMS

WELL: KA2-1

DEPTH INTERVAL	MUD TYPE	WEIGHT	API FLUID LOSS	YIELD POINT	PH	
0-100'	Gel and water	65#/ft³	---	15	9.0	
100-1000'	Gel and water or air*	70#/ft³	10cc	15	9.0	
1000-3500'	Gel and water or air*	70#/ft³	10cc	15	10.0	
3500-7000'±	Gel and water or air*	70#/ft³	3.2cc	15	10.0	
7000-T.D.	Water or air*	65#/ft³	or 3000 cfm			

REMARKS
*If unable to maintain circulation due to lost circulation, first attempt to aerate system, then attempt to drill with air with rotary bit or air hammer (see attached). If misting is required, it may be necessary to increase air volume 30%. Misting mix should be fresh water mixed with 2-6 gal/10BBls of Magcobar Foamer. Maintain a solution pH above 10.0 to inhibit corrosion. Use Unisteam as outlined in special considerations.

LOGGING

DEPTH INTERVAL	LOG TYPES	LOG SCALES
100-1000'*	Temperature log & logs as directed	1" and 5" = 100'
1000-3500'*	Temperature log & logs as directed	1" and 5" = 100'
3500-7000'	Temperature log & logs as directed	1" and 5" = 100'
7000-T.D.	Temperature log & logs as directed	1" and 5" = 100'
0-T.D.	Samples every 10'	--

REMARKS
All logs to be determined by geologist.
*Apply for waiver requiring E-log on these sections of the well.

WELLHEAD

API NOMINAL SIZE	WORKING PRESSURE PSI	TYPE	MAKE
26"	100 psi		
20" S.O.W. x 21-1/4" 2000	2000 psi	*Weld on wellhead	WKM
21-1/4" 2000 x 12" 900	3000 psi	21-1/4" x 12" expansion spool with two 3" 2000 outlets	WKM
12" x 12"	3000 psi	12" 900 Ansi WKM Pow-R-Seal master valve	WKM

REMARKS

DIRECTIONAL OR STRAIGHT-HOLE

Drill hole as straight as possible, taking directional shots every 100'± from 0-7000' and on dull bits after 7000'. 0-3500' maximum deviation to be 5°, maximum rate of change to be 1½° per 100'. 3500-7000' maximum deviation to be 8°, maximum rate of change to be 1½° per 100'. 7000-T.D. monitor without control.

TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA
220 South King Street
Suite 868
Honolulu, HI 96813
Telephone No.: 808-528-3496
FAX No.: 808-526-1772

RECEIVED
93 NOV 1 P 1:46
DIV. OF WATER & LAND DEVELOPMENT

November 1, 1993

Mr. Manabu Tagomori, P.E.
Chief Engineer
Division of Water and Land Development
State Department of Land and Natural Resources
Kalanimoku Building Room 227
1151 Punchbowl Street
Honolulu, Hawaii 96813

Subject: Request for Extension or in the Alternative, ~~Reapplication for Drilling Permits of Well Sites Numbers 2~~ and 3.

Dear Mr. Tagomori,

Enclosed are information to support the extensions or reapplications for drilling permits at well sites numbers 2 and 3. As you are aware, True Geothermal Energy Company (True), has been delayed in its efforts to commence drilling operations at the above described ~~locations, for various reasons.~~ However, True remains committed to commencing drilling operations again, as soon as the impediments to operations can be satisfied or removed.

Accordingly, we respectfully request your cooperation in processing the renewals or extensions of the permits in order that the permits can be made effective again. Although sometime has elapsed since the initial application was made, the drilling plans and strategy today remains the same for both wells. These documents were prepared by ThermaSource, Inc. and Mr. Gerald Niimi and Mr. Louis Capuano. As you know, ThermaSource, Inc., has been True's drilling consultant from the inception of the project and has extensive geothermal drilling experience, including operations in Hawaii. Should you have any questions regarding the foregoing, please do not hesitate to call me (528-3496) or Mr. Niimi (707 523-2960) at your convenience. Your speedy processing of this application will be greatly appreciated.

Very Truly Yours,

TRUE GEOTHERMAL ENERGY COMPANY
Allan G. Kawada

AGK/mab

Application For Permit to Drill a Geothermal Well

(Campbell Estate Parcel, Puna District, Island of Hawaii, TMK 1-2-10:3)

1. Regulatory Requirements

This application for Permit to Drill a Geothermal Well is submitted in accordance with the Department of Land and Natural Resources (DLNR) Rules on Leasing and Drilling of Geothermal Resources, Title 13, Chapter 183, Paragraph 65. The information on drilling operations required in the Plan of Operations is included and combined with like requirements in the Application for Permit to Drill as described below.

Since all geothermal wells will be drilled generally in the same manner, most of the data in this Application will be applicable to all wells. Therefore, subsequent applications for a Permit to drill will include only new information applicable to the well to be drilled and any modifications to the current generic data applicable to all wells.

2. Applicant and Lease Provisions

The applicant is True Geothermal Energy Company, the Operator for True/Mid-Pacific Geothermal venture for the mining operations permitted under State Geothermal Mining Lease No. R-5 dated July 23, 1987 and issued to the Estate of James Campbell, Lessee. By Sub-lease Agreement between Campbell Estate and

Reference Material from KAI-1 Application

True Geothermal Energy Company and Mid-Pacific Geothermal, Inc., dated December 3, 1986, Campbell Estate assigned its rights to True/Mid-Pacific Geothermal Venture to drill for, produce and take geothermal resources from the lands leased under any state mining lease issued to Campbell Estate on the lands described in the sublease. By Operating Agreement between True Geothermal Energy Company and Mid-Pacific Geothermal, Inc., dated October 5, 1982, True is designated as "Operator" and Mid-Pacific as "Non-Operator" for the geothermal venture. The operator is responsible for all drilling operations under the terms and conditions of the mining lease. Agent for the operator is Mr. Allan Kawada whose address is: True Geothermal Energy Co., 888 Mililani Street, 8th Floor, Honolulu, Hawaii 96813-2918, Tel: 528-3496. The organization of the operator is shown in Figure 1.

3. Well Identification

Geothermal wells to be drilled in the Kilauea middle east rift zone (KMERZ) under Mining Lease No. R-5 will be identified in relation to: one of the Planned Exploration/Development Areas (A through E) as shown on Figure 2; the drilling site number; and, the sequential number of each well drilled at a particular site. Under this procedure, the first well for which this application is submitted, is designated as True/Mid-Pacific Exploration/Development Area A, Drilling Site 1, Well No. 1, or True/Mid-Pacific A1-1.

4. Purpose and Objective of Proposed Work

The purpose of the proposed work is to explore for geothermal resources by

Operator For Resource Exploration & Development

PROJECT ORGANIZATION

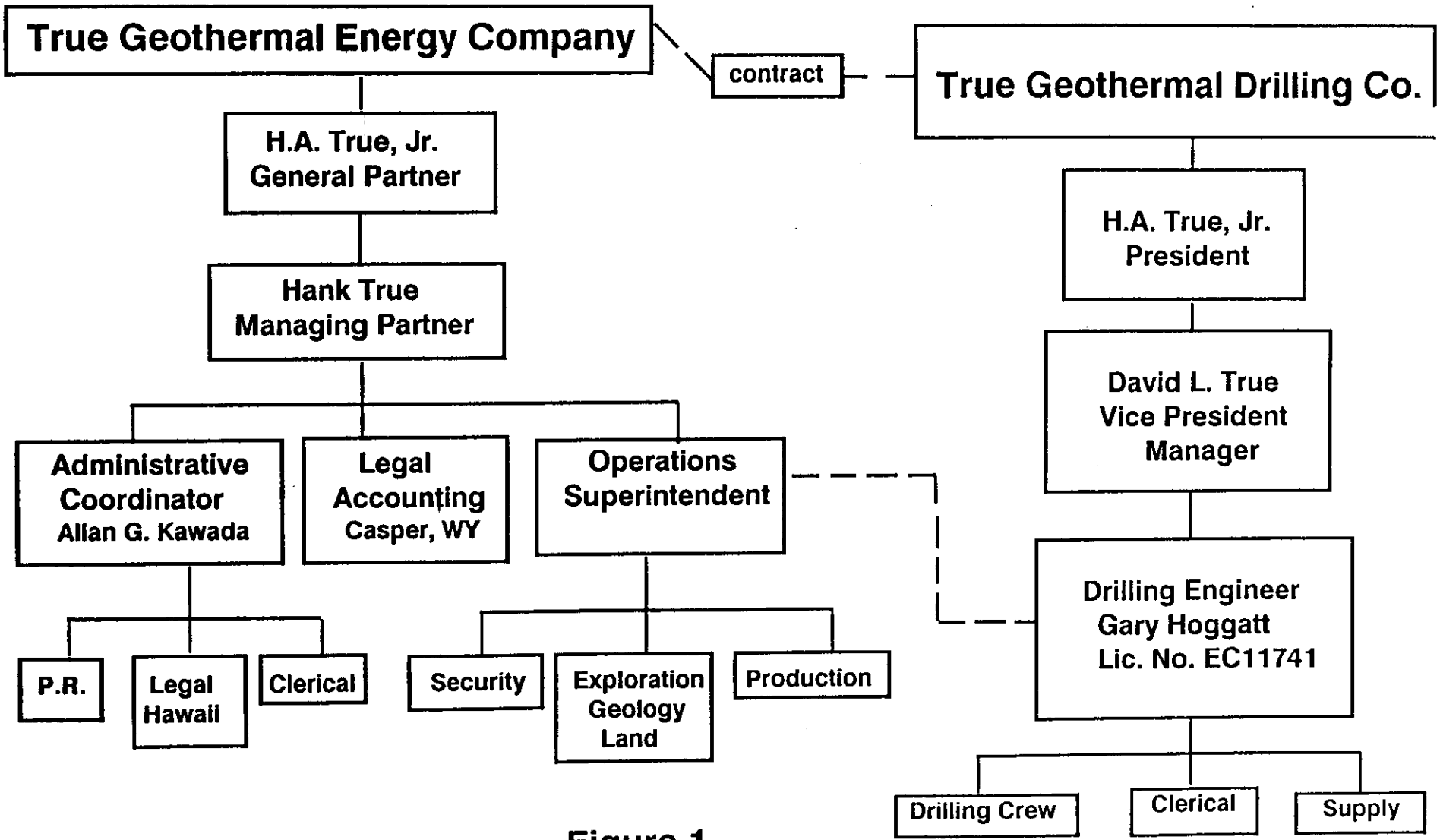


Figure 1

deep drilling into the area underlying the drilling site to depths between 8,000 feet and 14,000 feet and evaluate any discovered reservoir through flow testing and analyses of the resource to determine whether such energy sources can be economically produced to generate electricity. Discovery of a geothermal resource may occur in a zone beginning at a depth of about 3,000 feet below sea level. The optimum production zone will be determined following analysis of well drilling data and flow testing of the well. Following a successful exploration well, the subsequent exploration drilling will be conducted for the purpose of determining the general dimensions and extent of the reservoir and to prove the existence of sufficient resources to satisfy a known or potential future market.

5. Planned Well Drilling, Well Completion and Testing Programs

(See Attachment 1)

It should be noted that changes in the drilling programs described in the Attachment will occur due to varying project site and sub-surface conditions encountered during these operations, the characteristics of the resource and changing technology. The required changes can be expected to involve primarily casing dimensions, drilling depths and direction, and well-head assembly -- none of which will affect safety or reliability of drilling and production operations. All changes will be reported to DLNR as they occur. DLNR will be notified in advance of all critical well operations and tests.

6. Performance Bonds, Idemnity, Liability

As required by Paragraph 13-183-34 of DLNR Administrative Rules, Operator will file a bond with the Department of Land and Natural Resources in the amount of $10,000 made payable to the State conditioned upon faithful performance of all requirements of Chapter 182, Hawaii Revised Statutes, the Administrative Rules of DLNR (Chapter 183) and the State Geothermal Mining Lease No. R-5.

As required by Paragraph 13-183-65 of DLNR Administrative Rules, a blanket indemnity bond of no less than $250,000 will be filed with DLNR within 10 days of well permit approval for drilling of True/Mid-Pacific A1-1 to inure to and indemnify the state and landowner against all losses, charges, expenses and claims for damages or injuries caused or resulting from the drilling and operation of the wells. In addition, general liability insurance in the following amounts will be in force prior to commencement of operations (construction of the access road into the project site):

a. Comprehensive General Bodily Injury Liability - $300,000 each occurrence, $1,000,000 aggregate.
b. Comprehensive General Property Damage - $50,000 each occurrence, $100,000 aggregate.

Additional liability coverage for injury or damage to persons or property caused by explosion, collapse, and underground hazards is to be added prior to initiating drilling operations. The land owner (Campbell Estate), the State of Hawaii, Hawaii State Board of Land and Natural Resources, the Chairman of

the Board of Land and Natural Resources and the Department of Land and Natural Resources shall be named insurers.

Operator will also, prior to commencing operations, deposit with DLNR and Campbell Estate a bond naming the State of Hawaii and Campbell Estate as obligees in a penal sum of not less than One Hundred Percent (100%) of the cost of such construction in a form and with surety satisfactory to both parties guaranteeing the completion of such work free and clear of all mechanics' and materialmen liens.

Operator commits to perform the proposed operations in accordance with DLNR Administrative Rules (Chapter 183) and all other federal, state and county requirements.

TRUE GEOTHERMAL ENERGY COMPANY
(Operator for True/Mid-Pacific Geothermal Venture)

_____
H. A. True, III, Partner

Attachment 1: Programs for Drilling.

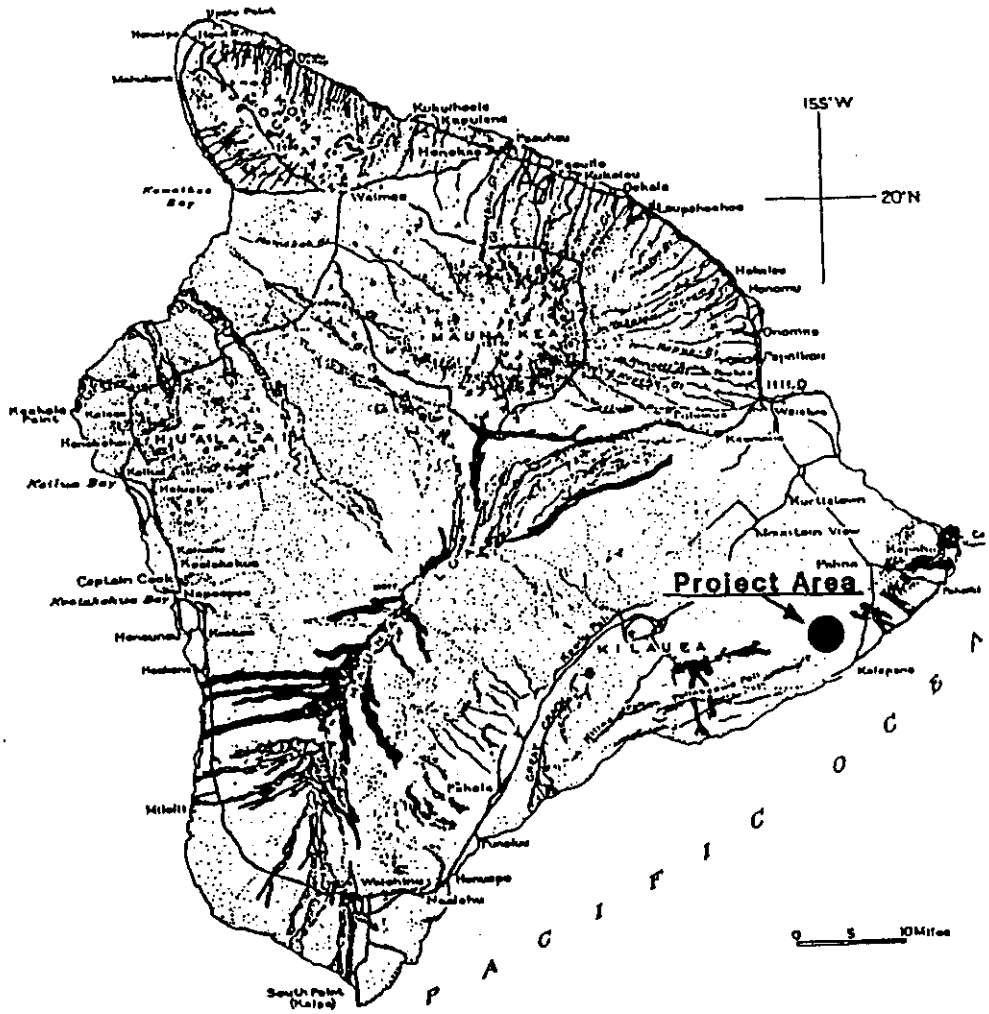
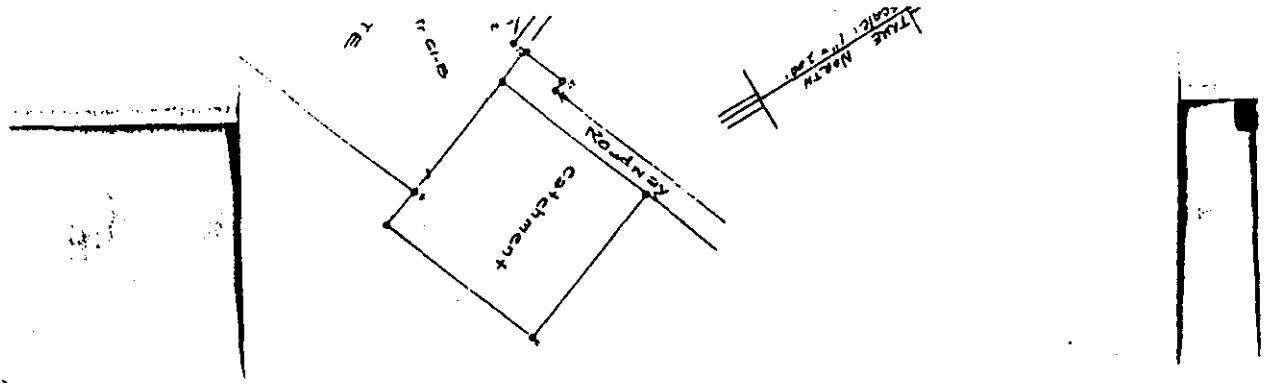


Figure 1. Project Area Map

(From Macdonald and Abbott 1970: 288)



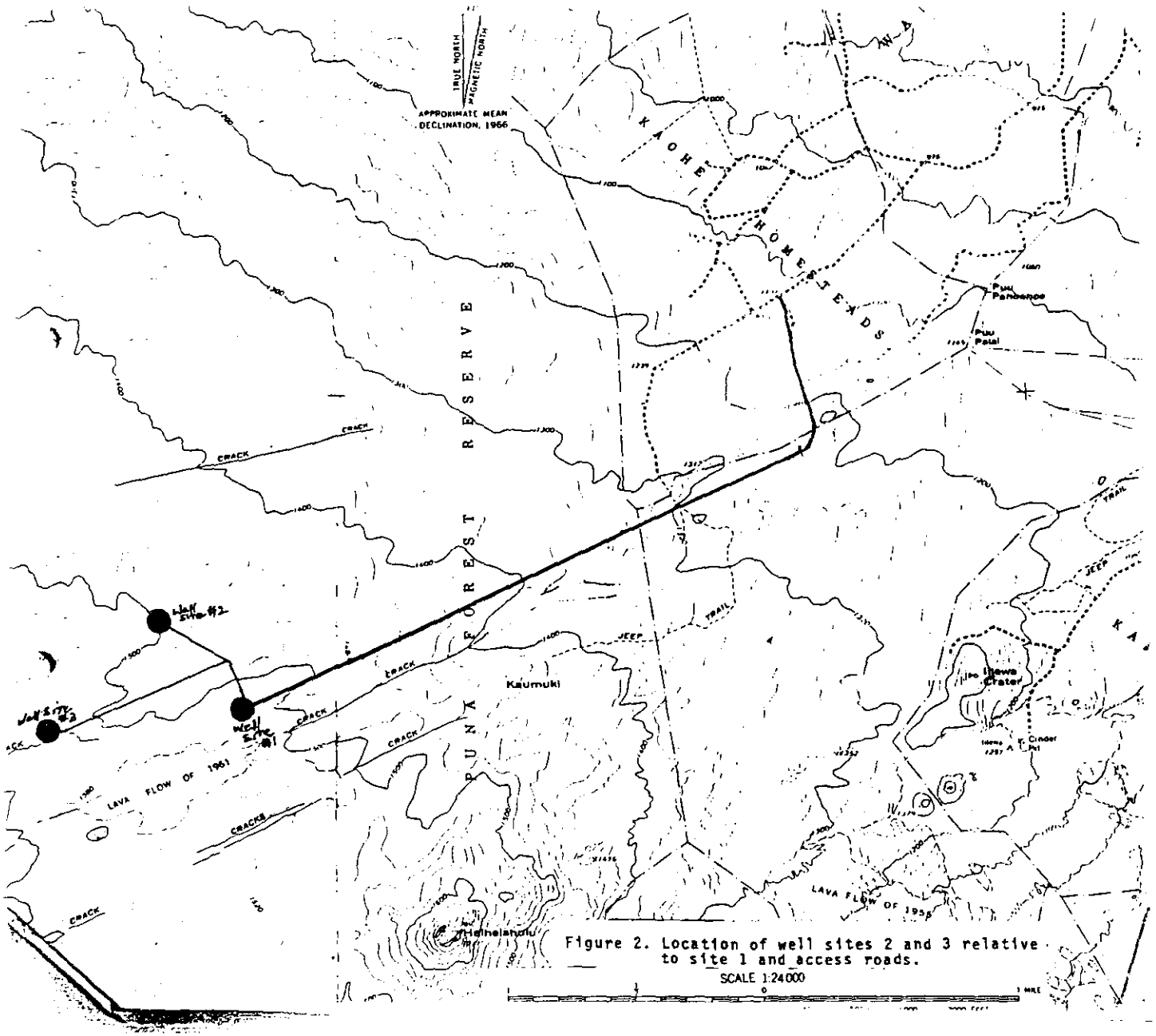
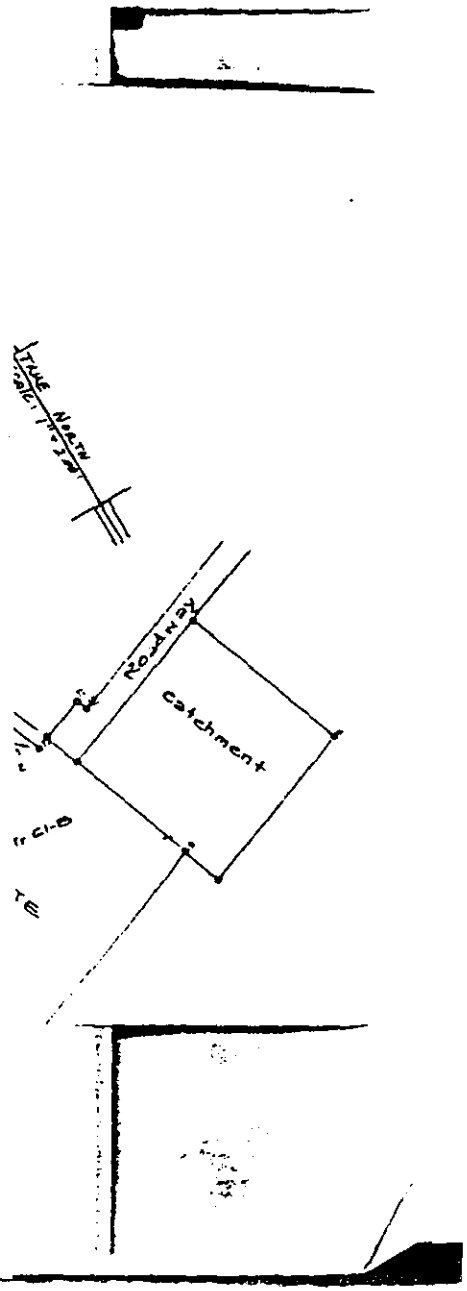


Figure 2. Location of well sites 2 and 3 relative to site 1 and access roads.

SCALE 1:24000



STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT
P.O. BOX 373
HONOLULU, HAWAII 96809

JAN 21 1994

Mr. Allan G. Kawada
True Geothermal Energy Company
Central Pacific Plaza
220 South King Street, Suite 868
Honolulu, Hawaii 96813

Dear Mr. Kawada:

KA2-1 AND KA3-1 Geothermal Well Drilling Permits

Enclosed for your attention and files are geothermal well drilling permits for Wells KA2-1 and KA3-1.

Please note that you are required to file an appropriate bond covering these two wells before any drilling activity can commence.

Should you have any questions, please call Gordon Akita of the Flood Control and Mineral Resources Branch at 587-0227.

Sincerely,

MANABU TAGOMORI
Manager-Chief Engineer

JF:ek
Enc.

GEOTHERMAL WELL DRILLING PERMIT

True/Mid-Pacific Well KA2-1
Puna District, Hawaii

TO: True Geothermal Energy Company
Central Pacific Plaza
220 South King Street, Suite 868
Honolulu, Hawaii 96813

Your application dated November 1, 1993, for a permit to drill a geothermal well on lands located within the Kilauea Middle East Rift Geothermal Resource Subzone and covered under the State of Hawaii, Geothermal Resource Mining Lease No. R-5 is Approved.

Well Designation: True/Mid-Pacific Well KA2-1
Location: TMK 1-2-10:03, Puna, Hawaii
Leased to: Estate of James Campbell (GRML R-5)
Subleased to: True/Mid-Pacific Geothermal Venture
Operator: True Geothermal Energy Company
Ground Elevation: 1,440 +/- ft. Above Mean Sea Level
Projected Depth: 10,000 +/- ft.

You are hereby granted permission to drill the geothermal well described above and in your application in accordance with the Department's Administrative Rules, Chapter 13-183, HAR, and under the following conditions:

(1) All work shall be performed in accordance with the permission and terms of the occupiers of the land, the Drilling and Completion Program submitted with your application, the Department's Administrative Rules (Chapters 13-183 and 13-184, HAR), and all other applicable Federal, State, and County laws, ordinances, rules, and regulations;

(2) The permittee, its successors and assigns shall indemnify, defend, and hold the State of Hawaii harmless from and against any loss, liability, claim or demand for property damage, personal injury and death arising out of any act or omission of the applicant, assigns, officers, employees, contractors and agents under this permit or relating to or connected with the granting of this permit;

(3) The permittee shall observe and comply with all valid requirements of County, State, and Federal authorities and regulations pertaining to the lands and permittee's operations including, but not limited to, all water and air pollution control laws and those relating to the environment;

(4) The well and bottom-hole location shall be located more than 100 feet from the outer boundary of the parcel of land on which the well is situated, or more than 100 feet from a public road, street, or highway dedicated prior to the commencement of drilling, unless modified by the Chairperson upon request;

(5) The permittee shall notify the Division of Water and Land Development (DOWALD), in writing, of the date of the start of drilling operations;

(6) Class "G" cement shall be used in the casing cementing operations and shall contain a high temperature resistant admix;

(7) All Blow-Out Prevention Equipment (BOPE) and cemented casing strings shall be pressure tested before commencing any other operation on the well. The minimum test pressures shall be approximately one-third of the casing internal yield pressure rating, provided that the test pressure shall not be less than 600 psig nor greater than 2500 psig, and shall be applied for a period of thirty minutes. The results of the pressure tests shall be reported on forms provided by the Department.

If a drop of more than ten percent of the casing test pressure is recorded, the operator shall run a caliper log and/or other appropriate well test to determine if the casing is defective and if corrective measures will be required before commencing any further operations. The results of the prescribed casing tests and any remedial work conducted shall be submitted to the Department within sixty days after completion;

(8) All personnel shall have BOPE training with periodic BOPE drills conducted and logged on daily tour sheets;

(9) Direct communications shall be installed between the rig floor, and both rig supervisor and the Operator's supervisor;

(10) A real time monitoring device shall be installed for the driller and a pit alarm system shall be included with this monitoring device. All toolpushers, drillers, and derrickmen shall be schooled in the use of the recommended monitoring equipment;

(11) If changes to the proposed drilling program are contemplated, the permittee shall obtain the Chairperson's approval before executing such changes;

(12) When drilling has reached a depth of not more than 50 feet below sea level, the Department's representative shall be notified, with reasonable time allowed for travel to the site, to witness the retrieval of a representative groundwater sample and the measurement of the static water level. The permittee shall have the sample analyzed by an independent laboratory and have the results submitted to the Department;

(13) During the use of the well for testing, monitoring, production and/or injection purposes, the well and site shall be properly maintained until the well is plugged and abandoned in accordance with the Department's Administrative Rules, Chapter 13-183, HAR;

(14) The Permittee shall submit to the Chairperson, the results of any exploration, all drilling and testing records, down-hole surveys of the well, bottom-hole location, date of completion, and a survey of the well location and elevation above mean sea level taken by a Hawaii licensed surveyor within six months after completion of the well;

(15) A well completion report, an as-built drawing of the well, and the location of the well plotted on an U.S.G.S. quad map shall be filed with the Department within six months after completion of the well;

(16) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface is restored as near as possible to its original condition; and

(17) This permit shall expire 365 days from the date of issuance.

Keith W. Ahue

KEITH W. AHUE, Chairperson
Department of Land and Natural Resources

JAN 21 1994

Date of Issuance

cc: Land Board Members
Hawaii County Planning Dept.
DBEDT
Department of Health
OEQC

KA2-1 permit

GEOTHERMAL WELL DRILLING PERMIT

True/Mid-Pacific Well KA2-1
Puna District, Hawaii

TO: True Geothermal Energy Company
Central Pacific Plaza
220 South King Street, Suite 868
Honolulu, Hawaii 96813

Your application dated November 1, 1993, for a permit to drill a geothermal well on lands located within the Kilauea Middle East Rift Geothermal Resource Subzone and covered under the State of Hawaii, Geothermal Resource Mining Lease No. R-5 is Approved.

Well Designation: True/Mid-Pacific Well KA2-1
Location: TMK 1-2-10:03, Puna, Hawaii
Leased to: Estate of James Campbell (GRML R-5)
Subleased to: True/Mid-Pacific Geothermal Venture
Operator: True Geothermal Energy Company
Ground Elevation: 1,440 +/- ft. Above Mean Sea Level
Projected Depth: 10,000 +/- ft.

You are hereby granted permission to drill the geothermal well described above and in your application in accordance with the Department's Administrative Rules, Chapter 13-183, HAR, and under the following conditions:

(1) All work shall be performed in accordance with the permission and terms of the occupiers of the land, the Drilling and Completion Program submitted with your application, the Department's Administrative Rules (Chapters 13-183 and 13-184, HAR), and all other applicable Federal, State, and County laws, ordinances, rules, and regulations;

(2) The permittee, its successors and assigns shall indemnify, defend, and hold the State of Hawaii harmless from and against any loss, liability, claim or demand for property damage, personal injury and death arising out of any act or omission of the applicant, assigns, officers, employees, contractors and agents under this permit or relating to or connected with the granting of this permit;

(3) The permittee shall observe and comply with all valid requirements of County, State, and Federal authorities and regulations pertaining to the lands and permittee's operations including, but not limited to, all water and air pollution control laws and those relating to the environment;

(4) The well and bottom-hole location shall be located more than 100 feet from the outer boundary of the parcel of land on which the well is situated, or more than 100 feet from a public road, street, or highway dedicated prior to the commencement of drilling, unless modified by the Chairperson upon request;

(5) The permittee shall notify the Division of Water and Land Development (DOWALD), in writing, of the date of the start of drilling operations;

(6) Class "G" cement shall be used in the casing cementing operations and shall contain a high temperature resistant admix;

(7) All Blow-Out Prevention Equipment (BOPE) and cemented casing strings shall be pressure tested before commencing any other operation on the well. The minimum test pressures shall be approximately one-third of the casing internal yield pressure rating, provided that the test pressure shall not be less than 600 psig nor greater than 2500 psig, and shall be applied for a period of thirty minutes. The results of the pressure tests shall be reported on forms provided by the Department.

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(8) All personnel shall have BOPE training with periodic BOPE drills conducted and logged on daily tour sheets;

(9) Direct communications shall be installed between the rig floor, and both rig supervisor and the Operator's supervisor;

(10) A real time monitoring device shall be installed for the driller and a pit alarm system shall be included with this monitoring device. All toolpushers, drillers, and derrickmen shall be schooled in the use of the recommended monitoring equipment;

(11) If changes to the proposed drilling program are contemplated, the permittee shall obtain the Chairperson's approval before executing such changes;

(12) When drilling has reached a depth of not more than 50 feet below sea level, the Department's representative shall be notified, with reasonable time allowed for travel to the site, to witness the retrieval of a representative groundwater sample and the measurement of the static water level. The permittee shall have the sample analyzed by an independent laboratory and have the results submitted to the Department;

(13) During the use of the well for testing, monitoring, production and/or injection purposes, the well and site shall be properly maintained until the well is plugged and abandoned in accordance with the Department's Administrative Rules, Chapter 13-183, HAR;

(14) The Permittee shall submit to the Chairperson, the results of any exploration, all drilling and testing records, down-hole surveys of the well, bottom-hole location, date of completion, and a survey of the well location and elevation above mean sea level taken by a Hawaii licensed surveyor within six months after completion of the well;

(15) A well completion report, an as-built drawing of the well, and the location of the well plotted on an U.S.G.S. quad map shall be filed with the Department within six months after completion of the well;

(16) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface is restored as near as possible to its original condition; and

(17) This permit shall expire 365 days from the date of issuance.

Keith W. Ahue

KEITH W. AHUE, Chairperson
Department of Land and Natural Resources

JAN 21 1994

Date of Issuance

cc: Land Board Members
Hawaii County Planning Dept.
DBEDT
Department of Health
OEQC

1130

TRUE GEOTHERMAL ENERGY CO.
IMPREST ACCOUNT
P. O. DRAWER 2360 237-9301
CASPER, WY 82602

November 26, 93 19

99-119/1023

PAY TO THE ORDER OF Department of Land & Natural Resources $ 200.00

--------Two Hundred Only and no/100 ---------- DOLLARS

HILLTOP National Bank
CASPER, WYOMING 82602

NOT GOOD FOR OVER $1,000.00

FOR

⑈001130⑈ ⑆102301199⑆ 089 77 5⑈

TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA

Telephone No.: 808-528-3496
FAX No.: 808-526-1772
220 South King Street
Suite 868
Honolulu, HI 96813

T R A N S M I T T A L

TO: Department of Land & Natural Resource
Manabu Tagomori,
Chief Engineer
1151 Punchbowl Street
Honolulu, Hawaii 96813

DATE: November 26, 1993

RE: A check for drilling permit # 2, & 3.

COPIES	DATE	DESCRIPTION
	November 26, 1993	Check for Drilling Permit # 2 & 3.

TRUE

TRANSMITTED FOR:

{ } Your Information and Files
{ } Signature and Return
{ } Further Action
{ } Your Review and Comment
{ } Per Your Request
{ } See Remarks Below

TRUE GEOTHERMAL ENERGY COMPANY

By Marilyn A. Bermudez for
Allan G. Kawada

992

wem

TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA
220 South King Street
Suite 868
Honolulu, HI 96813

Telephone No.: 808-528-3496
FAX No.: 808-526-1772

91 OCT 31 A9:29

October 30, 1991

Mr. William Paty
Director
Department of Land and Natural Resources
State of Hawaii
1151 Punchbowl Street, Room 224
Honolulu, Hawaii 96813

ATTN: Mr. Manabu Tagomori

SUBJECT: SUBMISSION OF DRILLING PROGRAMS FOR DRILL OR WELL SITES NUMBERS 2 AND 3, KILAUEA MIDDLE EAST RIFT ZONE, PUNA, HAWAII

Dear Mr. Paty:

Enclosed are the proposed drilling programs for True Geothermal Energy Company's drill sites numbers 2 and 3. The programs were prepared pursuant to the requirements of the Department of Land and Natural Resource's Rules on Leasing and Drilling of Geothermal Resources (Title 13, Subtitle 7, Chapter 183). We wish also to incorporate by reference the information contained in our permit to drill sent to the engineers of DLNR by letter dated February 1, 1989. The locations of drill sites numbers 2 and 3 are noted on a map sent to DLNR by letter dated October 23, 1991.

The programs were prepared in consultation with ThermaSource, Inc., who have acted as our drilling consultants for the past ten years.

Your review and concurrence are respectfully requested for the submittals. Should you have any questions please call me at 528-3496 or Mr. Gerald Niimi of ThermaSource, Inc., at (707) 523-2960. Thank you for your attention.

Very truly yours,

TRUE GEOTHERMAL ENERGY COMPANY

Allan G. Kawada

AGK/reg

encl.

JOHN WAIHEE
GOVERNOR OF HAWAII

KEITH W. AHUE, Chairperson
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

JOHN P. KEPPELER, II
DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P.O. BOX 621
HONOLULU, HAWAII 96809

REF:WL-LN

October 11, 1993

Mr. Allan G. Kawada
True Geothermal Energy Company
Central Pacific Plaza
220 So. King St., Suite 868
Honolulu, HI 96813

Dear Mr. Kawada:

KA2-1 AND KA3-1 Well Drilling Permits

This is to inform you that True/Mid-Pacific's geothermal well drilling permits for KA2-1 and KA3-1 have expired as of December 13, 1992.

Accordingly, any re-initiation of work on these wells will require the submittal of new application with $100 filing fee per well and the approval and issuance of new permits.

Should you have any questions on this matter, please feel free to contact Mr. Manabu Tagomori of the Division of Water and Land Development at 587-0230.

Very truly yours,

KEITH W. AHUE
Chairperson

TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA
220 South King Street
Suite 868
Honolulu, HI 96813

Telephone No.: 808-528-3496
FAX No.: 808-526-1772

RECEIVED
92 AUG 20 A10: 31

DIV. OF WATER & LAND DEVELOPMENT

August 19, 1992

Mr. Manabu Tagomori
Chief Engineer
Division of Water and Land Development
Department of Land and Natural Resources
Kalanimoku Building, Room 227
P.O. Box 621
Honolulu, Hawaii 96809

SUBJECT: **SUBMITTAL OF CORRECTION SHEET TO DRILLING PROGRAM FOR WELL SITES NUMBERS 2 AND 3 (DATED OCTOBER 1991).**

Dear Mr. Tagomori:

Enclosed is a corrected page 2 to be substituted into the drilling programs for the above described well sites.

The purpose of the substitutions is to correct typographical errors in Items 10 and 11 of the program.

In recent discussions with your staff engineers, these errors were found and in response to those discoveries, we are submitting these corrections.

Should you have any question, please do not hesitate to call me at 528-3496.

Very truly yours,

TRUE GEOTHERMAL ENERGY COMPANY

Allan G. Kawada

AGK/reg

enclosure

possible, take drift shots every 100'. Maximum rate of change 1 degree per 100'. Install mud loggers at surface to log entire well from 0' to total depth. Catch three clean and dry samples every 10'.

6. Rig up and run 20" casing to total depth as per attached 20" casing program with 20" stab-in float collar and float shoe on bottom.

7. Once 20" casing has been run to bottom, run in hole with stab-in tool on bottom of drill pipe and stab into float collar. Circulate hole clean with at least two full circulations.

8. Cement 20" casing through drill pipe as per attached program. Circulate cement back to surface between 20" and 30" casing. Observe cement level. If cement falls back in annulus, bring same back to surface with 1" pipe.

9. Wait on cement 8 hours.

10. Land 20" casing. Cut off and remove 30" conductor drilling nipple. Cut off 20" casing and weld on 20" S.O.W. x 21-1/4" 2000 psi wellhead. Install two 3" valves and diverter. Install 20" blow out preventer equipment as per attached Figure 003.

11. Test 20" casing and blow out preventer equipment to 1000 psi for 30 minutes.

12. Drill out cement and float collar and float shoe from 20" casing with 17-1/2" bit using mud. Drill 30' of formation and trip to pick up stabilization.

13. Continue to drill 17-1/2" hole as vertical as possible with mud to 3500'+/- as indicated by formation. Directionally survey well at least every 100'. If lost circulation presents severe problems, an aerated mud system may be utilized. Severe loss circulation zones should be cemented off prior to drilling ahead.

14. Once 17-1/2" hole has been completed to casing point, rig up and run logs if indicated by geologic staff.

15. Upon completion of logging program, run in hole with bit and circulate to condition hole for casing.

16. Rig up and run 13-3/8" casing as per attached 13-3/8" casing program and running procedure. If lost circulation presents severe problems during drilling it may be necessary to set 13-3/8" pipe as a liner then tie it back to the surface rather than a full string of casing. See running procedure for alternative options.

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER RESOURCE MANAGEMENT
P. O. BOX 373
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
DAN T. KOCHI

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER RESOURCE MANAGEMENT

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Company: Univ. of Hawaii

From: D. Nakano

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Message: Approval & Supplemental Act Prep.

Total number of pages (including Transmittal Page): 3

* * * * * * * * *

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TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA

Telephone No.: 808-528-3496
FAX No.: 808-526-1772
220 South King Street
Suite 868
Honolulu, HI 96813

May 10, 1991

Mr. Manabu Tagomori
Deputy Director
Department of Land and Natural Resources
Kalanimoku Building, Room 227
Honolulu, Hawaii 96813

Re: Third Archaeolgical Report on Well Site Number 2

Dear Mr. Tagomori:

Enclosed are two copies of the above described archaeological report for your review and concurrence. The report describes additional field work at Well Site Number 2 and its buffer area that was requested by the Department to supplement an earlier archaeological report also prepared for Well Site Number 2. The field work has been described to your staff and concurred with after a field investigation by them.

It is our opinion that the report adequately describes the additional field work accomplished and the expert conclusions rendered by Mr. Joseph Kennedy.

Should you have any questions, please call me at 528-3496.

Very truly yours,

TRUE GEOTHERMAL ENERGY COMPANY

By _____
Allan G. Kawada

AGK/rp

TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA

Telephone No.: 808-528-3496
FAX No.: 808-526-1772
220 South King Street
Suite 868
Honolulu, HI 96813

F A X

T R A N S M I T T A L

DATE: November 12, 1991 TIME: 10:05 AM

FROM: Allan G. Kawada FAX NO. 808-526-1772

TO:

FAX NO: 587-0219

COMPANY: Dept. of Land and Natural Resources

ATTN: Ms. Janet Swift

RE: Letter dated October 15, 1991
HISTORIC PRESERVATION REVIEW, as requested.

NUMBER OF PAGES (Including this page): 3

REMARKS:

Please contact (808) 528-3496 if you did not receive all pages.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

REF: HP-JLR

OCT 15 1991

Mr. Allan G. Kawada
True Geothermal Energy Company
200 South King Street, Suite 868
Honlulu, Hawaii 96813

Dear Mr. Kawada:

SUBJECT: Historic Preservation Review of Revised Archaeological Inventory Report for Proposed Geothermal Well Site #2 Former Puna Forest Reserve, Puna, Hawaii
TMK: 1-2-10: 3

Thank you for submitting for our review the revised archaeological survey report (Kennedy 1991. An Inventory Survey at the Site of the Proposed Kilauea Middle East Rift Zone (KMERZ), Well Site #2. TMK: 1-2-10:3. Island of Hawaii. Archaeological Consultants of Hawaii.).

This report has been submitted to comply with the terms and conditions of the Decision and Order of the Board of Land and Natural Resources (April 11, 1986) which called for an approved archaeological survey of all well pads and buffer zones around them. For proposed Well Site #2 and the adjoining buffer, we determined earlier (Ltr. Paty to Kawada, Jan. 29, 1991) that the fieldwork for the archaeological inventory survey adequately demonstrated that grubbing and grading could proceed with "no effect" on historic sites. This determination was made after our staff inspected the field work and with the understanding that an adequate inventory survey report would need to be submitted and accepted by the Historic Preservation Division. This report has been submitted to fulfill this condition.

We have reviewed the revised report and find it to be an adequate archaeological inventory report. It sufficiently depicts the field work conducted and demonstrates that no historic sites are present on the surface of the project area. We agree that you are in full compliance with the historic preservation survey conditions of the Decision and Order.

Several agreed upon mitigation measures still need to be followed during preparation of the drill site and drilling (Ltr. Paty to Kawada, Jan. 7, 1991). These include: (1) having your consulting archaeologist instruct your field staff and contractors on the

identification and treatment of archaeological remains, (2) notifying your consulting archaeologist and our State Historic Preservation Division if any archaeological sites or lava tubes are found during construction, (3) using a 1 1/2" drill bit for the first 100' of drilling and (4) stopping all drilling activity if a void of 8' or more is encountered during the first 100' of drilling.

Should you have any questions, please call our office. Dr. Ross Cordy, our Branch Chief for Archaeology, is temporarily the contact person for Hawaii Island reviews (587-0012).

Very truly yours,

WILLIAM W. PATY, Chairperson and
State Historic Preservation Officer

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY
CHAIRPERSON

JOHN C. LEWIN, M.D.
MICHAEL J. CHUN, Ph.D.
ROBERT S. NAKATA
RICHARD H. COX
GUY K. FUJIMURA

MANABU TAGOMORI
DEPUTY

MAY 20 1991

MEMORANDUM

TO: Mr. Don Hibbard, Administrator
Historic Preservation Division

FROM: Manabu Tagomori, Deputy Director

SUBJECT: Inventory Survey of Proposed Kilauea Middle East Rift Zone (KMERZ) Well Site #2, TMK: 1-2-10:3, Island of Hawaii

Transmitted for your review and acceptance is the archaeological survey report for the third increment of fieldwork for the True/Mid-Pacific Geothermal Venture Well Site #2.

Please review the attached document and, if you find it acceptable, prepare a letter of approval for signature by the Chairperson. Our understanding is that the historic preservation fieldwork concerns have been met and that no archaeological sites were found near the proposed well site. I would appreciate your providing the Division of Water Resource Management a file copy of the signed letter.

Thank you for your continued cooperation. Should you have any questions, please contact Gordon Akita, Manager-Chief Engineer at Ext. 8-7496.

DN:dk
Enclosures

ORNITHOLOGICAL SURVEY

OF THE

PROPOSED

GEOTHERMAL WELL SITE # 2

DLNR DESIGNATED GEOTHERMAL RESOURCE SUBZONE
KILAUEA MIDDLE EAST RIFT ZONE
PUNA DISTRICT
ISLAND OF HAWAII

AUGUST 16, 1990

BY

JACK JEFFREY

PREPARED FOR:

TRUE/MID PACIFIC GEOTHERMAL VENTURE

INTRODUCTION

The U.S. Fish and Wildlife Service (USFWS 1983) and the State of Hawaii (DLNR 1986) have listed as endangered six forest bird species for the Island of Hawaii. Two of these birds, the O'u (*Psittirostra psittacea*) and the Hawaiian hawk (*Buteo solitarius*) may be present within the Geothermal resource sub-zone (Scott et al. 1986). Thus, their presence could impact future development within the resource area. This report presents the results of a bird survey conducted August 11 and 12, 1990 in the sub-zone in and around the proposed well site and pad for True/Mid Pacific Geothermal Well #2.

METHODS

One eight-minute count was conducted at each of nine stations in the area of the proposed well drilling site and pad clearing on each of two consecutive days. The count period was begun at 6:15 a.m. in order to use the high calling/song rate period of birds occurring during the first three hours after dawn. Birds were detected aurally or visually using the Variable circle plot count method (Ramsey and Scott 1979) for detection and recording. Each bird was recorded by species, distance and direction from the trained observer. On Day One, birds were counted at consecutively numbered stations placed 400 feet apart in an ascending manner while moving into the forest from the access road around the well site. On Day Two, the stations were censused in reverse, that is, in a descending manner from the well site to the access road. This was done to remove any temporal bias in calling/song rates as the observer moved from station to station within the study site. Some bird species may call only just after sunrise with decreasing rates thereafter. These birds would not be calling later in the day, and therefore not detected, when the observer reached the last stations. (Scott and Ramsey 1981).

Any unidentified calls and species seen or heard while walking along the transect were considered as incidental observations and not included in the data summary except to be added to the species list.

This survey was conducted along the access road and in the forest covering an area equivalent to five times the proposed well pad area for Well Site #2 in the Kilauea middle east rift zone, Puna District, on the Island of Hawaii. (See maps #1, 2 & 3). The study site is approximately 1420 feet in elevation.

Counts were conducted at nine stations placed at least 400 feet apart in all directions. This spacing was used to maintain enough area between stations to eliminate repeat counts of loud species as recommended in Ramsey and Scott 1979.

FINDINGS

Two hundred sixty-two (262) birds comprising nine (9) species were counted during the two day survey (Table One and Two). Five (5) native species made up 65% of the detections. Of these only one, the Hawaiian hawk, is considered an endangered species. Four (4) non-native species comprised 35% of the total. Most endemic species were detected with equal frequency throughout the forested study site but two species, the Hawaiian hawk and the Elepaio were observed infrequently at the study site.

Apapane was the most commonly detected native species making up 33% of all birds observed and averaged 4.8 birds per station. Most likely this nectivorous species was attracted to the numerous ohia trees (Metrosideros polymorpha) that were in bloom through out the area.

Japanese white-eyes were the second most common species observed making up 26% of the total and averaged 3.7 birds per station. This alien species is ubiquitous throughout the forested areas on all major Islands in the Hawaiian chain. Being found from sea level to tree line, it is the most common bird found in Hawaii (Scott et al 1986).

The next most commom species found during the survey (21% of the total) was the Omao or Hawaiian thrush. This bird, commonly found at higher elevations was detected at a rate of 3.1 birds per station, an unusually high number for such a low elevation. This species is common in forests above 3000 feet on the Big Island except for the Kona side and the Kohala Mountains where it dissappeared earlier in this century for unknown reasons. Other species of this genus found on other Hawaiian Islands are only found in low nuwbers and are all but extinct (Scott et al 1986 and personal observations).

Three observations of two individual endangered Hawaiian Hawks were made during the two day survey. One Hawaiian Hawk nest with a nestling was found out side of, but within approximately 400 feet of the proposed well site.

The nestling was first seen and heard approximately 50 feet from the nest on the first day of the survey. On the

second day the young bird was seen perched on the edge of the nest and was later fed by one of the parents.

During an earlier survey in July an unusual slightly upslured whistle was heard on several occassions. This unidentified call was again heard during this survey but this time more numerous than during the previous survey. It was determined that the source of this unusual sound was the Omao or Hawaiian Thrush. This observer had never heard this particular Omao call before. This type of vocalisation is probably a dialect of the Omao repertoire in this area. It could be confused with a similar up slurred whistle call of the O'U if an observer were not familiar with Omao calls.

DISCUSSION

Only one endangered species, the Hawaiian hawk, (three sightings) was detected during the survey. This bird ranges wide during foraging forays and is found throughout various native and non-native habitats on the Island of Hawaii. The presence of this bird and the active nest in the study site is not unique as Hawaiian hawks are known to live and nest throughout the Puna district (Griffin 1985, Jeffrey 1986, Scott et al. 1986).

The presence of an active hawk nest within 400 feet of the well pad should be treated with caution. Loud noises and constant human activity around nests are known to cause nest (egg and nestling) abandonment and mortality in many bird species including hawks. The nesting period of the Hawaiian hawk (March-August) is the most vulnerable to this type of disturbance (Griffin 1985).

Normally, Hawaiian hawks begin nesting in March/April when the eggs are laid and with most hatching occurring in mid-June. Most nestlings fledge during August (about 8-9 weeks after hatching) but remain in the natal territory for over a year begging food from the parents. There is a high frequency of nest reuse in subsequent years. (Griffin 1985)

The nestling at the study site nest is very close to fledging. It appeared close to adult size and was seen to fly at least 50 feet from the nest, perching in an adjacent tree. During a second observation, a parent was observed bringing a food item to the nestling at the nest on which the nestling immediately began to feed.

In order to prevent disturbance of the nest at the site it is reccommended the no clearing of the pad begin until the hawk nestling fledges (2-3 weeks). This can be determined by

weekly observations of the nest from a distance so as to not disrurb the nestling or adults, until the fledgling discontinues using the nest. Also, the nest should be monitored again in the spring to watch for reuse by the parents. Monitoring should continue if the nest is reactivated. Information on the effects of disturbance from nearby well activity is important. Very little is known about Hawaiian Hawk nesting and human disturbance and this would be a good opportunity to gather this type of information for future reference.

Other endangered species that are found in ohia forests (Hawaii Akepa, Hawaii Creeper) are limited to higher elevations (Scott et al. 1986) and have not been seen at elevations below 2000 feet since the early 1900's (Berger 1988). None of these species were found below 3600 feet during the Hawaii Forest Bird Survey of 1976-81 (Scott et al. 1986). Therefore, it is unlikely that either of these two species would occur within the study area.

A third endangered species, the O'u, also found in ohia forests was once a common species in the wet forests and were known to move from high elevations to low elevations during feeding forays. (Perkins in Berger 1988) Only one sighting was made during the Hawaii Forest Bird Survey in the Puna area (Scott et al. 1986). Although O'u calls are a loud, clear upslurred or downslurred whistle and fairly distinctive, the bird is rarely detected and has been confidently identified on the Island of Hawaii only once (Olaa Tract) in the last five years (USFWS pers com). This species still may occur in unexplored areas. Occasionally unconfirmed sightings are reported on the Island of Hawaii (1988-1990, 3 sightings, USFWS pers com). None were detected during this survey.

The Amakihi, Apapane and Omao are widely distributed over the study area in consistently moderate numbers whereas, the Elepaio was detected in very low numbers on only three of the nine stations. The presence of these four species of native birds in a low-elevation ohia forest is unique. Nowhere else in Hawaii can native bird species be found below 2000 feet elevation (Scott et al. 1986).

Disease, predation, competition from non-native bird species and habitat fragmentation are suspected agents in the demise of all Hawaii's native forest bird species. This is especially prevalent at low elevations. It has been assumed that disease has been the primary contributing factor in the decimation of native birds in low elevation habitats (Scott et al 1986, Scott et al. 1988). The presence of these four species at the study site elevation challenges these disease assumptions. This particular anomoly requires further study.

Forest fragmentation and distruction has led to the extinction of birds and plants worldwide and is of great concern to developers and biologists alike. With careful planning and cooperation in developement plans that include Hawaii's native forests we will help preserve this important component of Hawaii's native ecosystems.

Table 1.

Species Names

Native Species

AMAK	Common Amakahi	*Hemignathus virens virens*
APAP	Apapane	*Himatione sanguinea sanguinea*
ELEP	Elepaio	*Chasiempsis sandwichensis ridgwayi*
OMAO	Omao	*Myadestes obscurus*
HAHA	Hawaiian Hawk	*Buteo solitarius*

Introduced Species

HOFI	House Finch	*Carpodacus mexicanus*
JAWE	Japanese White-eye	*Zosterops japonicus*
NOCA	Northern Cardinal	*Cardinalis cardinalis*
MLTH	Melodious Laughing-thrush	*Garrulax canorus*
SPMU	Spotted Munia	*Lonchura punctulata*

Table 2.

Species and numbers of individuals detected at stations along the Proposed access road and at Well site #2.

DAY ONE

Station	1	2	3	4	5	6	7	8	9	
Species										TOTAL
AMAK	0	0	3	3	1	1	2	4	0	14
APAP	5	5	4	3	9	5	5	4	3	43
ELEP	0	0	0	0	0	0	0	0	0	0
HAHA	0	0	0	0	0	1	0	0	0	1
OMAO	4	4	4	3	3	3	2	3	3	29
JAWE	6	2	4	4	3	4	5	5	2	35
MLTH	3	2	2	2	0	0	0	2	1	12
NOCA	0	1	1	0	0	0	0	0	0	2
SPMU	0	0	0	0	0	0	0	0	2	2
										138

DAY TWO

Station	1	2	3	4	5	6	7	8	9	
Species										TOTAL
AMAK	1	1	2	1	0	0	3	0	0	8
APAP	6	4	6	4	4	3	7	4	5	43
ELEP	1	1	0	0	1	0	0	0	0	3
HAHA	0	0	0	0	1	1	0	0	0	2
OMAO	3	3	2	2	5	3	3	2	4	27
JAWE	6	2	4	3	2	1	5	4	5	32
MLTH	0	2	0	0	0	2	1	2	1	8
NOCA	0	0	0	0	1	0	0	0	0	1
SPMU	0	0	0	0	0	0	0	0	0	0
										124

TWO DAY TOTAL 262

LITERATURE CITED

DLNR 1986. Indigenous wildlife, endangered and threatened wildlife and plants, and introduced wild birds. Department of Land and Natural Resources. State of Hawaii, Administrative Rule 28 August 1986.

Griffin, C.R. 1985 Biology of the Hawaiian Hawk Buteo solatarius. Ph. D. Dissertation. University of Missouri, Columbia.

Jeffrey, J. 1986 Hawaiian Hawk Survey in the Pu'u Honuaula Area. Puna Geothermal Power Company Report. 14pp.

Perkins, R.C.L. Notes on collecting in Kona. Pp 120 in Berger A.J. 1988. Hawaiian Birdlife. University of Hawaii Press, Honolulu.

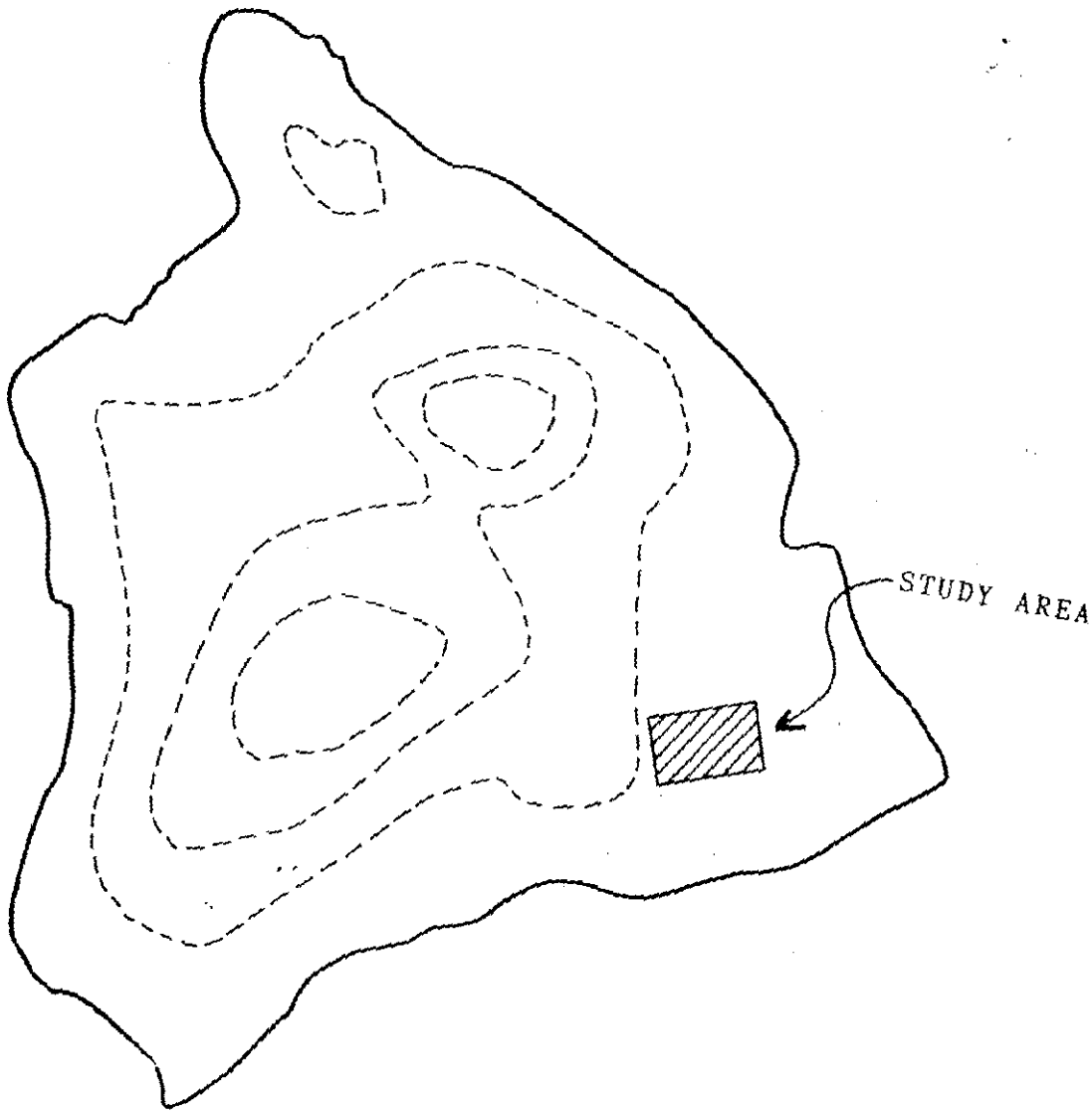
Ramsey, F.L., and J.M. Scott 1981. Estimating population densities from variable circular plot surveys. Pp 155-181 in R.M. Cormakc, G.P. Patil and D.S. Robson (eds). Sampling biological populations. Stat. Ecol. Serv., Vol. 5. Co-op. Publ.House, Fairland, MD.

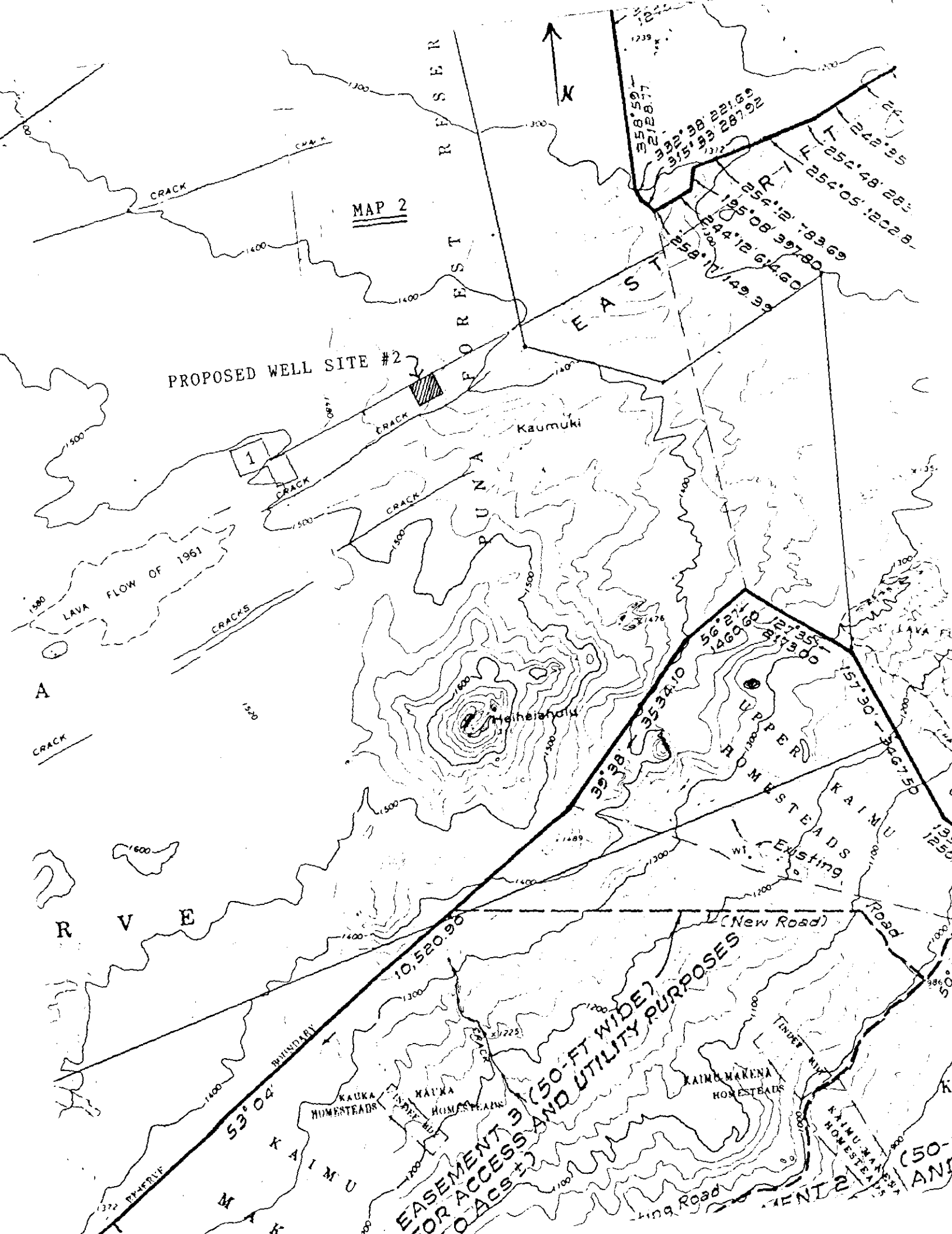
Scott, J.M. and F.L. Ramsey. 1981. Length of count period as a possible source of bias in estimating bird numbers. Pp. 409-413 in C.J. Ralph and J.M. Scott (eds). Estimating numbers of terrestrial birds. Studies in Avian Biology No. 6. Cooper Ornithological Society.

Scott J.M., S. Mountainspring, F.L. Ramsey, and C.B. Kepler 1986. Forest bird communities of the Hawaiian Islands: their dynamics, ecology, and conservation. Studies in Avian Biology No. 9. Cooper Ornithological Society.

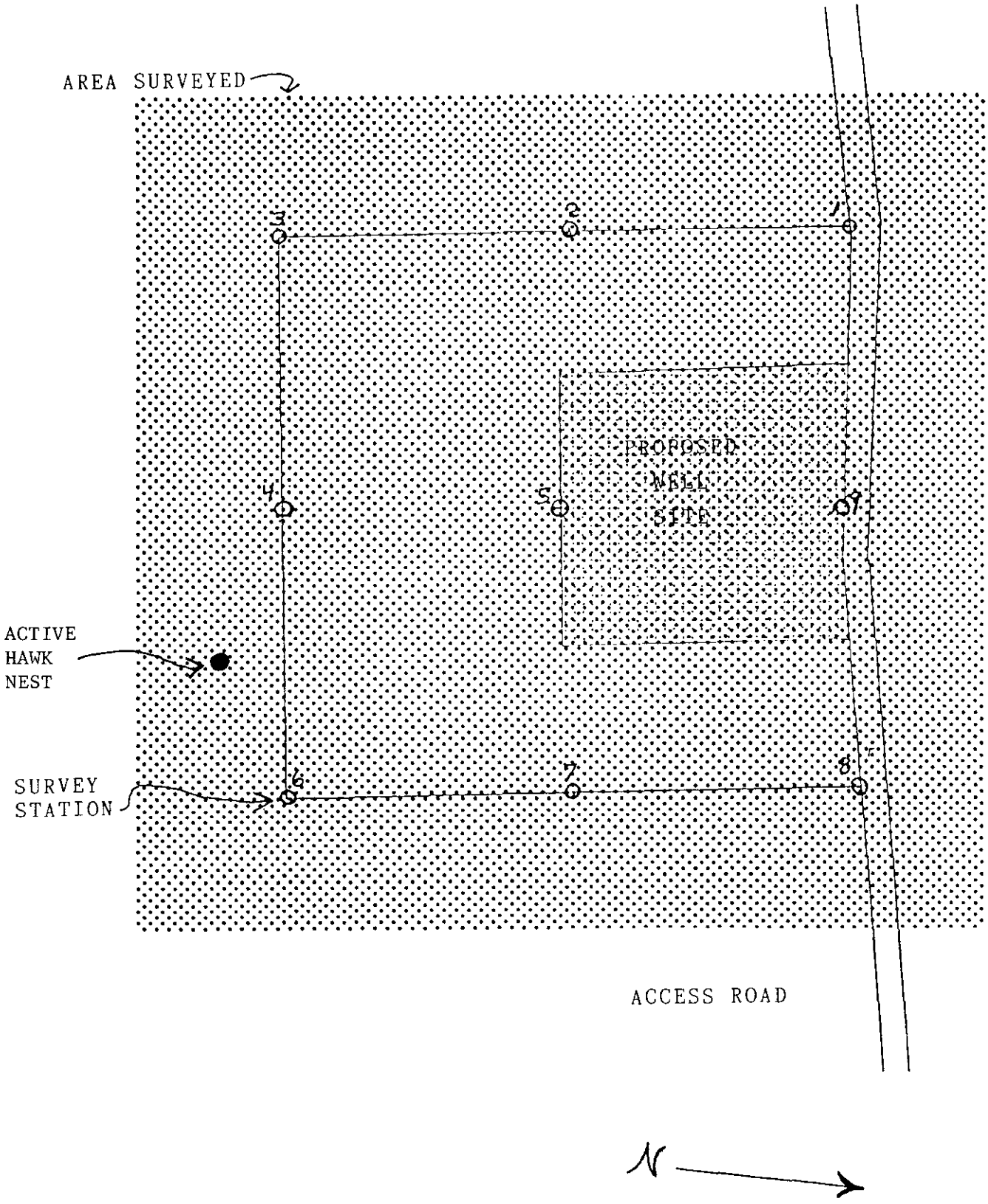
Scott, J.M., C.B. Kepler, C. van Riper III, S.I. Fefer 1988. Conservation of Hawaii's vanishing avifauna. Bioscience 38:238-253.

MAP 1




MAP 2
PROPOSED WELL SITE #2
EAST
FOREST
RESER
Kaumuki
Hoheiahalu
LAVA FLOW OF 1961
CRACKS
CRACK
UPPER KAIMU HOMESTEADS
Existing Road
(New Road)
10,520.90
53° 04'
BOUNDARY
EASEMENT 3 (50-FT WIDE) FOR ACCESS AND UTILITY PURPOSES
KAUKA HOMESTEADS
KAIMU MAKENA HOMESTEADS
KAIMU HOMESTEADS
RESERVE
MAKAI
KAIMU
R V E
A
T 242°35'
F 254°48' 28"
254°12' 783.69
195°08' 397.80
244°12' 614.60
258°10' 149.39
358°58'
212.77
332°38' 221.69
315°33' 287.52
56° 27'
146.60
127.35'
313.00
157°30'
246.75
39°38'
353.10

MAP #3


AREA SURVEYED
1
2
3
4
5
PROPOSED
WELL
SITE
7
8
ACTIVE
HAWK
NEST
SURVEY
STATION
6
ACCESS ROAD
N

REF: HP-JLE

JAN 29 1991

Mr. Allan Kawada
True Geothermal Energy Company
220 South King Street, Suite 868
Honolulu, Hawaii 96813

Dear Mr. Kawada:

SUBJECT: Historic Preservation Compliance for True Geothermal Energy Company Proposed Well Site Number 2 (KMERZ)
Former Puna Forest Reserve, Puna, Hawaii
TMK: 1-2-10: 3

Pursuant to the terms and conditions of the Decision and Order of the Board of Land and Natural Resources dated April 11, 1986, a full archaeological survey is to be conducted and approved prior to any clearing activities for each drill site and roads in the project area. This survey, which is called an archaeological inventory survey by our department, is to cover all areas to be cleared for construction and an area two to five times that to be developed. The procedures for the survey work are spelled out in the Research Design called for in the Decision and Order, with this design having been amended by joint agreement in the Fall of 1990 to accommodate the potential presence of lava tubes with significant historic remains at or in the vicinity of proposed well sites.

To comply with this survey requirement, True Geothermal Energy Company has conducted an archaeological inventory survey of proposed Well Site Number 2 and a buffer quadrat around it. This survey has been done in three fieldwork increments. Results of the first two increments were submitted to the Department in separate reports (Reports of Archaeological Consultants of Hawaii dated September 6, 1990 and October 26, 1990). After reviewing these two reports, it was concluded by our department that the survey methods for the two increments already completed had to be clarified in the report and that the survey fieldwork had not yet adequately covered the project area specified in the revised Research Design, necessitating a third increment of fieldwork.

Your consulting archaeologist, Mr. Joseph Kennedy, carried out this third increment of fieldwork, and as requested, he arranged for a staff archaeologist from our department to conduct a field inspection with his field crew on the last day of their work. The staff member inspected portions of proposed Well Site Number 2, accompanied the field crew on two survey sweeps north of the main access road and noted the intervals between the flagged survey sweeps leading off the access road. A lava tube segment found during this increment of fieldwork also was inspected. It lies along the eastern boundary of the Well Site and runs in a Southwest to Northeast direction. There was no evidence of past human use in the tube segment and, based on the condition of the lava tube, the probability that it was used appears low. The tube could not be followed for more than several hundred feet

JAN 2 9 1991

up-slope and down-slope where ceiling collapse and lava seals block passage. Based on these observations and discussions with the field crew, the State Historic Preservation Division is satisfied that the combined coverage of the three increments constitutes adequate fieldwork for an archaeological inventory survey and that no archaeological sites are present.

The department therefore feels that historic preservation fieldwork concerns have been adequately met for proposed Well Site Number 2. Full compliance with the historic preservation survey conditions will only be complete when an adequate inventory survey report of the third increment of the fieldwork has been submitted and accepted by the department (to include a map depicting areas covered by the survey transects). However, in this case, with no sites having been found, we believe that proceeding with the grubbing and grading will have "no effect" on historic sites, with the understanding that an adequate survey report must still be submitted and accepted at a later date.

Several agreed upon mitigation measures (Ltr. Paty to Kawada, Jan. 7, 1991) need to be followed during preparation of the drill site and drilling. These include (1) having your consulting archaeologist instruct your field staff and contractors on the identification and treatment of archaeological remains and (2) notifing your consulting archaeologist and our State Historic Preservation Division if any archaeological sites or lava tubes are found during construction, using a 7 1/2" drill bit for the first 100' of drilling and stopping all drilling activity if a void of 8' or more is encountered during the first 100' of drilling.

In sum, this letter serves as written approval that you have complied with the historic preservation survey fieldwork concerns. Since no historic sites were found, this letter further authorizes the commencement of clearing activities for Well Site Number 2. This authorization is contingent on your obtaining all necessary state and county permits (including the medicinal plants, grading and grubbing permits) prior to any clearing or excavation.

Should you have any questions, please call Manabu Tagomori, Deputy Director, at 548-7533.

Very truly yours,

/S/ WILLIAM W. PATY

WILLIAM W. PATY
Chairperson and State
Historic Preservation Officer

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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

REF: HP-JE

JAN 10 1991

Mr. Allan Kawada
True Geothermal Energy Company
200 South King Street, Suite 868
Honolulu, Hawaii 96813

Dear Mr. Kawada:

SUBJECT: Historic Preservation Review of True Geothermal Energy Company Proposed Well Site #2 (KMERZ) Former Puna Forest Reserve, Puna, Hawaii
TMK: 1-2-10: 3

On December 27, 1990, members of the State Historic Preservation Division and the Division of Water Resource Management met with you and your consulting archaeologist, Joseph Kennedy, to reach an agreement on what archaeological work and mitigation measures are needed before and during proposed drilling at Well Site #2. Discussions centered on two draft reports of the archaeological inventory survey conducted for Well Site #2, our written comments on this pending survey and your responses to some of our concerns. Also discussed were the guidelines for archaeological work set out in the Research Design mandated by the Decision and Order of the CDUA (April 11, 1986) and recommended revisions to these guidelines which were agreed to in our meeting of October 1990. These revisions have been prompted by the results of previous compliance work in the area and our study of the lava tubes in the former Puna Forest Reserve.

The following summarizes the major points agreed upon at the meeting:

1. Confusion Over Changes in Project Plans. The meeting clarified to our satisfaction confusion over use of the terms Well Site #2 and Pad A in the documents submitted for our review. We understand that these two sites are identical in location, size and configuration. Confusion arose when an alternative well site called Pad B was introduced to the project plans because of concerns over a nearby hawk nest. Pad B was subsequently eliminated from the project plans but only partially removed from portions of the documents submitted.

2. Steps Needed to Complete Archaeological Inventory Survey for Well Site #2. First, it was agreed that ambiguities in the description of survey coverage would be clarified in the final survey report. The description we received stated that "visual assessment of surface conditions was maintained for a width of no more than twenty feet to each side of the each corridor, whose width is estimated to be approximately ten feet, or the average distance between the two team members as they traveled the corridor." To us, this indicated that a total of 50 ft. was surveyed along each corridor. The current survey report must be revised to clarify this description of how the survey sweeps were conducted and demonstrate that total coverage along each corridor was greater than a total of 50 ft. and was, thus, equivalent to the map which Mr. Kennedy had at the meeting.

   Second, from our discussions it was clear that portions of Well Site #2 had not been covered by the survey sweeps. It was agreed that this would be covered before submittal of the final report.

   Third, we addressed the problem of complete survey of the entire survey quadrat (1,000 feet upslope of the pad, 1,000 feet downslope, and 500 feet to each side), as required by the revised research design agreed to in October. It was agreed that survey sweeps would be made in areas which were marked at the meeting on the schematic map of the survey area (Fig. 4, Ltr. Report, Kennedy to Kawada Oct. 26, 1990). This included corridors between those already covered on the southern side of the existing access road and coverage within an area located directly north of Well Site #2. This area was shaded on the map during the meeting and should extend no more than 500 ft. north of the road. As we have stated repeatedly in our written comments, we realize that the terrain is rough and hazardous and we do not ask that anyone place their life in danger.

3. Field Check by State Historic Preservation Division and Review of Final Report. We agreed that a field inspection will be undertaken by our staff while the survey team is completing the survey specified above. Our concurrence to proceed with grubbing and grading can then be given if no sites are found, with the understanding that an acceptable final archaeological report shall be submitted later. If sites are found, then acceptable mitigation measures will need to be developed.

4. Monitoring of Grading and Grubbing. The Research Design requires that an archaeologist inspect all areas subject to disturbance after initial grading and grubbing. The research design, as revised, agreed that this step is no longer necessary because it has not proven useful at the previous sites inspected.

   Grading and grubbing could expose historic remains or an undetected lava tube. Thus, your proposal that your consulting archaeologist brief all True Geothermal Energy Company field staff and contractors involved in clearing, construction activities and drilling at Well Site #2 is an excellent suggestion. While the identification of lava tubes is of particular concern in this area, other archaeological site types and deposits should also be described. If historic remains or a lava tube are exposed, we will make every effort to assess the situation and proposed appropriate action as soon as possible.

5. Measures to Minimize Potential Damage to Remains in Undiscovered Lava Tubes during Drilling. To avert potential damage to historic remains in undiscovered lava tubes, we accept the measures which you suggested. For the first 100' of drilling, a smaller bit (7 1/2") will be used and drilling will stop if a void of 8 ft. or more is encountered. You stated that your choice of 8 feet instead of 6 was based on the advice of your drilling advisors who felt that voids less than 8 feet in height may not be detected reliably. A camera device would be lowered into the void as a means of assessing whether or not the void is a lava tube which could have historic remains or burials. To assure rapid appraisal of a void, we agree to have a staff member either at the drill site or on the island while the first 100 ft. is being drilled.

There are two additional points we want to clarify before closing. We left the meeting with the impression that there may be a misunderstanding about the State Historic Preservation Division's review process and how it applies within the context of this particular project.

First, there appeared to be a tendency to see our review comments as asking for a series of additional conditions and surveys. In regard to Well Site #2, our requirements for more work have been part of a single review process for a single inventory survey which has not yet been completed. This inventory survey can be

considered complete only when it meets the requirements of the CDUA conditions, the revised Research Design mandated by the CDUA and the standards set forth in our historic preservation program's Draft Rules and Regulations which are used to evaluate all archaeological reports. Thus, instead of asking for additional archaeological work, we have had to ask several times that this inventory survey meet specified requirements.

Second, both the Research Design for geothermal exploration in the former Puna Forest Reserve and the historic preservation Draft Rules and Regulations have standard provisions to deal with what we call "inadvertent discoveries." These are instances in which new information or unexpected historic properties are discovered after a project has been through the historic preservation review process and they are deemed of sufficient value to require reopening the review process or modification to mitigation measures stated in the permit conditions. We consider the results of our study of lava tubes in the former Puna Forest Reserve to be an example of this because it demonstrates that the likelihood of burials and other historic remains is higher than previously realized. Thus, in our October meeting, we agreed upon revisions to the Research Design requirements for inventory surveys and mitigation measures during site clearance and drilling. The size and configuration of the buffer zone that we now require to be surveyed is less than the maximum potentially required by the CDUA (two to five times the area to be disturbed). We see our requirements for the inventory survey and the mitigation measures to be used during drilling as an honest attempt to accommodate our heightened concern for significant remains in the area, the existing conditions of the CDUA permit and the various constraints your project may be facing.

If you have any questions please contact Ross Cordy at 587-0012 or Holly McEldowney at 587-0008.

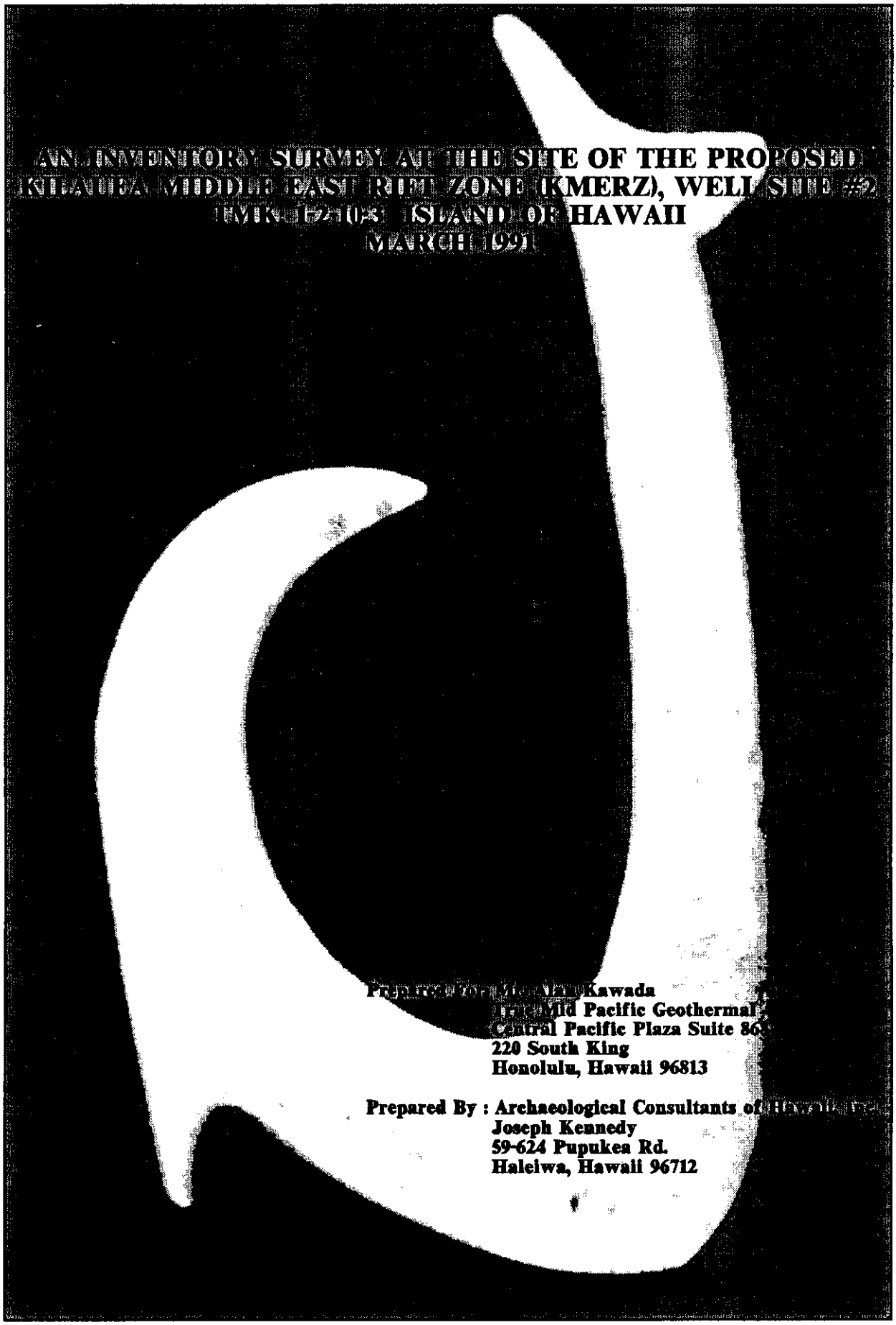
Very truly yours,

/S/ WILLIAM W. PATY

WILLIAM W. PATY
Chairperson and State
Historic Preservation Officer

AN INVENTORY SURVEY AT THE SITE OF THE PROPOSED KILAUEA MIDDLE EAST RIFT ZONE (KMERZ), WELL SITE #2 TMK: 1-2-10:3 ISLAND OF HAWAII

MARCH 1991



Prepared for: Mr. Art Kawada
The Mid Pacific Geothermal
Central Pacific Plaza Suite 86
220 South King
Honolulu, Hawaii 96813

Prepared By : Archaeological Consultants of Hawaii, Inc.
Joseph Kennedy
59-624 Pupukea Rd.
Haleiwa, Hawaii 96712

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March, 1991

INTRODUCTION AND PHYSICAL SETTING

At the request of True Mid Pacific Geothermal, Archaeological Consultants of Hawaii, Inc. has conducted an inventory survey at the site of the proposed Kilauea Middle East Rift Zone (KMERZ), Well Site #2, TMK: 1-2-10:3. The Principal Investigator was Joseph Kennedy M.A., assisted by Jacob Kaio, Field Supervisor and field crew Mark Borrello B.A., Michael O'Shaughnessy B.A., and Randy Adric. This report supercedes all previous reports submitted to the Historic Preservation Section of the Department of Land and Natural Resources.

In addition to 100% surface coverage of the 400 x 400 foot well pad itself, 100% surface coverage of a substantial buffer zone was also completed.* This buffer zone was established by the Department of Land and Natural Resources, Historic Preservation personnel and extends 1000 feet east and west of the well site and 500 feet north and south of the well site.

This proposed well site and buffer zones are located on the Kilauea Middle East Rift Zone, Island of Hawaii (see maps Figure #1 and Figure #2). The subject property features an extremely rugged topography and an unusually thick vegetative profile which combine to present some of the most difficult survey areas in the state. A thick mat of stony muck rests on what appears to be alternating a'a and pahoehoe and is covered with very dense uluhe, 'ie'ie, hapu'u, guava, ohi'a and a number of additional plants, vines and grasses. The area surveyed is comprised of bog and swamp, dominated by a mixed mesic-type rainforest of 'ohi'a, hapu'u, Kilauea hepyotis, and assorted epiphytic vegetation such as mosses, ferns, and 'ala'alawainui. The majority of 'ohi'a appears to be stunted, probably a result of the boggy conditions. Included to a lesser degree are 'akala, guava, waiawi, 'ie'ie, maile, mamaki, kolea, assorted gingers (mostly 'awapuhi), occasional fleabane, bamboo, orchid, iris and lobelia.

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* Three small areas along the southern boundary of the buffer zone were not examined due to extremely hazardous topographic conditions.

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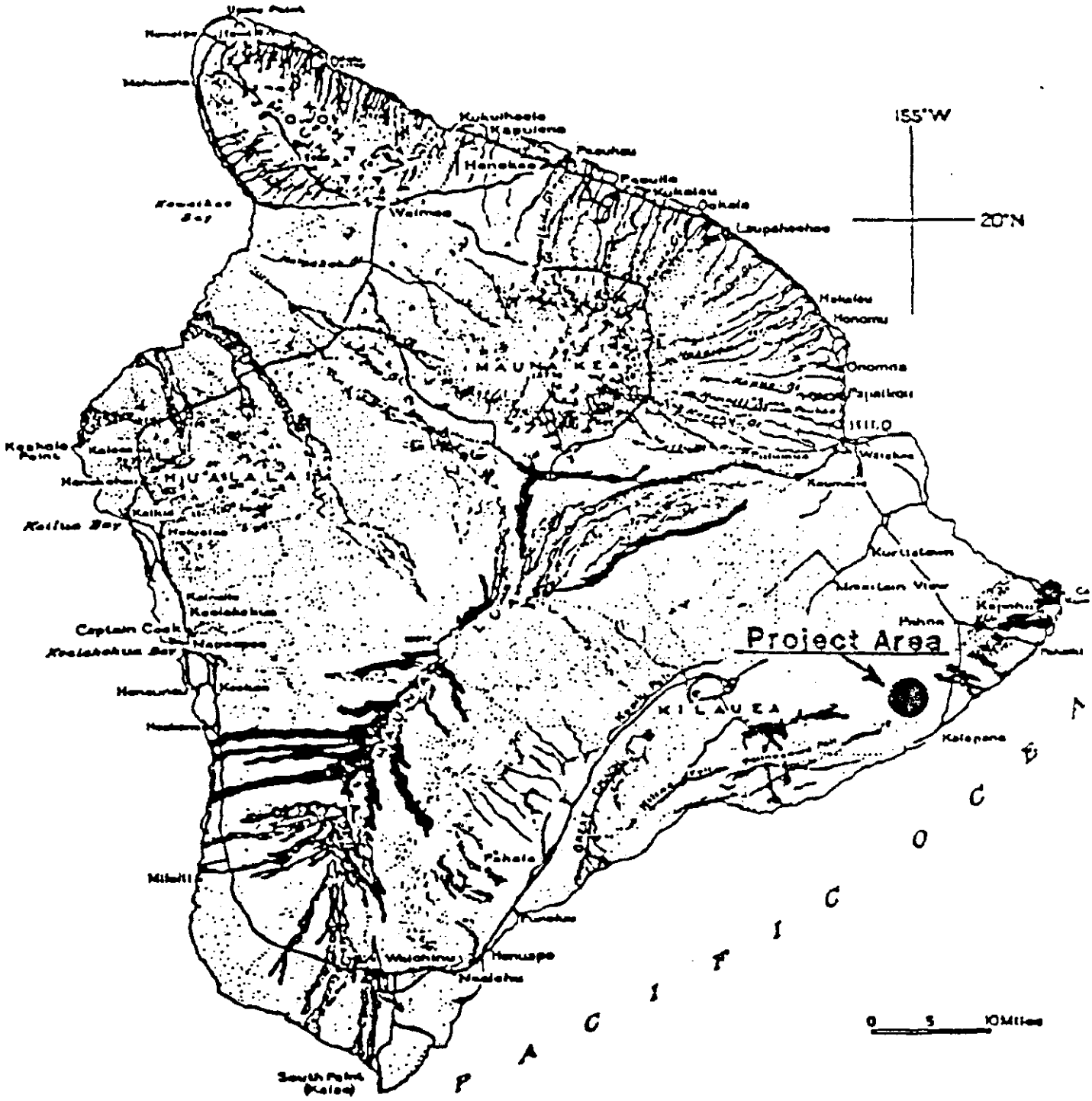

Figure 1. Project Area Map
(from Macdonald and Abbot 1970: 288)

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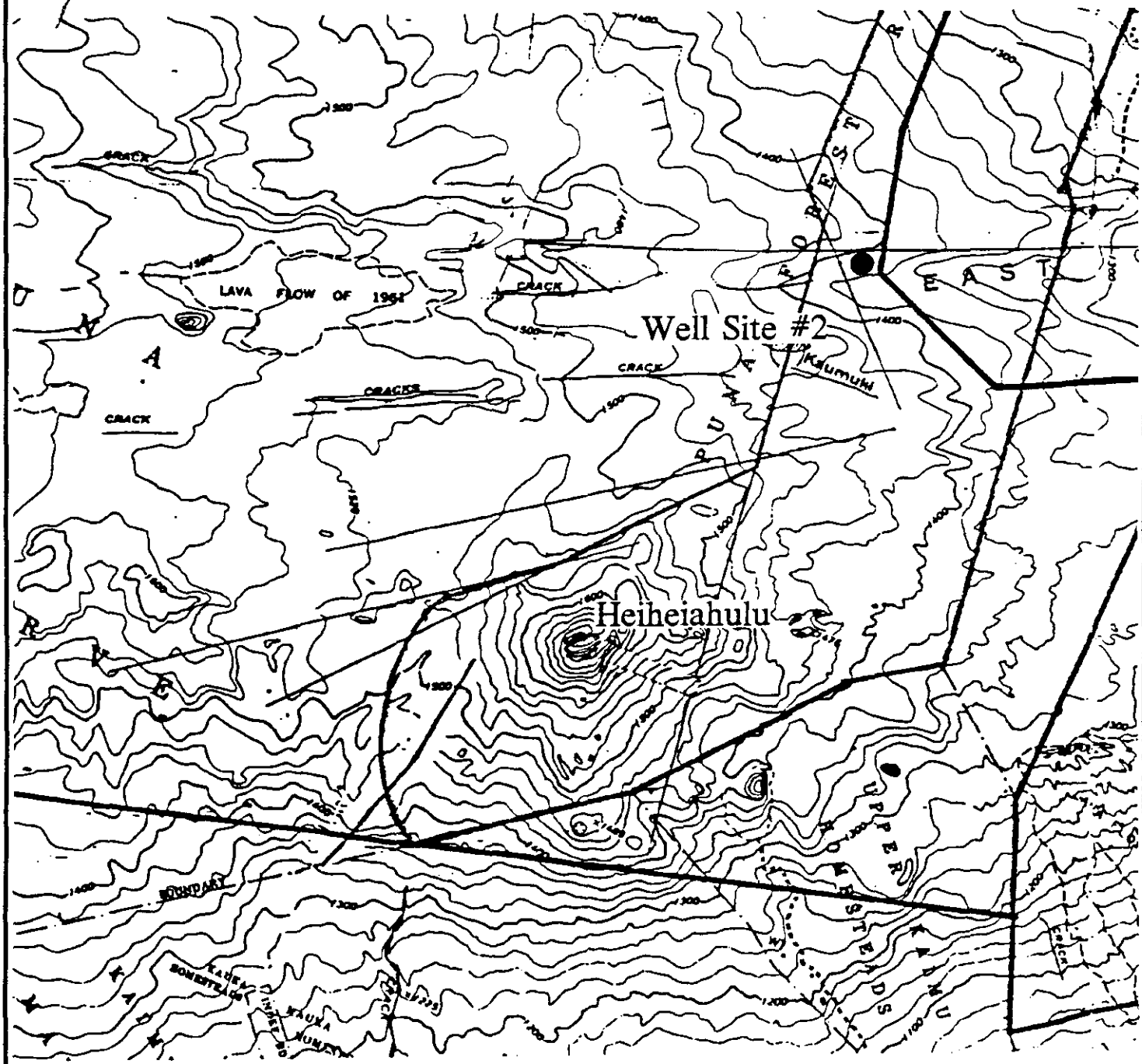

Figure 2.
Location Map Well Site #2

The roadway bulldozer push (approximately 25 feet on either side) consists mostly of fleabane, mamaki, 'akala, bamboo orchid, iris, guava, a species of melastoma candida, and other exotics. The reader may wish to refer to the numerous and recently completed botanical studies of this area for a more complete listing.

The land mass appears to be mostly pahoehoe, deduced indirectly by the smoothness of the surface and poor drainage conditions of this surface. Small outcrops of a'a were also observed. The pahoehoe is covered with either mud and water, mosses, or a mixture of all three. The mud, soil, and decayed vegetation occurred at a depth of approximately one foot. The mud areas have all been used extensively by pigs, as is evidenced by rooting digging, and chewed hapu'u. In areas in which there are fallen 'ohi'a and/or hapu'u, there are few, if any, caves of any consequence or size. Another observation was the lack of birds. We encountered only a few cardinals, a few finches or sparrows (limited visibility hampered identification). Notably absent is the presence of mongoose.

PURPOSE OF WORK

A variety of archaeological sites may be expected in the vast forest lands where True/Mid-Pacific Geothermal Venture proposes to conduct its geothermal exploration activities. Although the sites' distribution generally will be sparse and although most project activities may well miss any sites that may exist there, it is important to have adequate plans to identify historic sites in order to avoid them or else mitigate any impacts to them.

Special identification problems exist in forest lands, and for this reason an archaeological research design for archaeological survey methods was required under CDUA HA-1830 as part of an archaeological plan. This document was prepared by the author on May 28, 1989 and later amended by the Department of Land and Natural Resources, Historic Preservation Program personnel.

PREHISTORIC AND EARLY HISTORIC LAND USE IN THE PROJECT AREA AND ANTICIPATED HISTORIC SITES

Historic and archaeological research in this area as well as in other similar environmental zones on Hawaii Island, indicate that prehistorically such areas were used for:

1. Forest product exploitation. Bird feathers, timber, vines, etc. were collected in the forests at or near worksites, and campsites were nearby. These sites may be scattered around some portions of the project area, in low densities for any one point in prehistory.

2. Burial. These sites are expected to be focused in certain areas.

3. Major inland trails across many ahupua'a and associated campsites. These sites should be focused in linear corridors.

4. Agriculture in the seaward-most reaches. These sites may tend to be fairly dense but they will again be in a small, seaward portion of the project area.

Archaeologically, the sites should have the following characteristics:

1. Forest exploitation sites. Probably there will be no surface stone architecture (huts and shelters likely were simply pole and thatch). Some campsites will be in caves. Each site may be a small scatter of flaked stone, broken tools, food remains (bone, shell), and firepits. If repeated use occurred, then the density of remains would be greater. Such campsites are documented in caves in forest areas. Such cave campsites have yielded a great deal of important information on the age of use of an area, on birds and plants collected. etc. Campsites and exploitation sites have yet to be documented in open-air context, and in such cases, they are expected to primarily be subsurface, buried sites.

2. Burials. Burials in forest areas have been identified in two forms --burials in caves (often caves also used as campsites) and in stone platforms and pavings on cinder cones. These sites contain important information on age of permanent occupation in an area, on social organization, on health, on demography. Additionally, they are highly significant sites culturally for native Hawaiians.

3. Trails. Trails in forest areas are expected to be extremely difficult to identify, as worn paths and cuts through the forest will have been covered over by later sediments and by forest regrowth. On bare a'a flows, there will be some visible features -- e.g., crushed paths, stepping stones. Campsites along the trails should have firepits, food remains, and some scattered artifacts. Some campsites may have been in caves, but others will have been open-air camps, and may have no surface architecture and be buried like the forest exploitation camps. Trails and their associated campsites can tell us a great deal about the nature of different time periods of travel across regions. Trails also provide information on items being carried or exchanged.

4. Agricultural sites. These sites commonly have some kind of stone-work --small oval clearings lined with stones, small terrace lines, walls, etc. These sites contain important chronological information on permanent settlement of an area, population expansion, and agricultural expansion.

SITE IDENTIFICATION PROBLEMS

Common archaeological surface survey (labelled reconnaissance survey, intensive survey, etc.) can identify cave sites used for forest exploitation and/or burial, can identify agricultural sites, and can identify trails on bare a'a flows. However, cave sites are only expected in older pahoehoe areas, not on a'a flows and not in recent pahoehoe areas. Platform and paving burial sites are expected to be restricted to cinder cones. Agricultural sites will be at lower, seaward elevations in areas with soil. This means that a'a flows and recent pahoehoe flows are not expected to include sites unless there is a visible trail remnant.

The open-air sites in forest areas -- trail sites (and their associated camps) and forest exploitation sites (not in caves) -- will likely be subsurface. They will also be small. Common surface survey will not be able to identify these sites when they are subsurface. These sites are expected in soil areas within kipuka, and on old pahoehoe flows, and on older a'a flows lacking rough surfaces. These sites may be surface remains on bare lava, in kipuka, on old pahoehoe flows and on older a'a flows lacking rough surfaces - in such cases, common surface survey could identify them, however, it appears unlikely that these sites will be found on the surface. They are not anticipated on rough a'a flows (except rare trails) or on recent pahoehoe or a'a flows. The above problems indicate two special conditions for site identification;

1. Some areas appear not to need survey. - - e.g., rough a'a flows and recent lava flows (post 1880 flows whether pahoehoe or a'a); these areas need to be identified and be clearly marked off as areas needing no archaeological work.

2. Soil areas may contain subsurface exploitation and trail related sites. Special archaeological approaches need to be devised for these areas to try and identify these sites.

BACKGROUND PREPARATION: FINDINGS

1. Check of historic and archaeological literature. The historic literature (Holmes 1985) shows no recorded trails in the project area. The Wilkes route of 1840 (see map Figure #3) passes to the south of the project area and the Kaimu Trail, approximately .75km to the south, skirts south of Heiheiahulu. The existence of the existing Kaimu Trail lowers the probability of an additional trail passing through the study area but increases the possibility that the area was accessed prehistorically.

Previous archaeological surveys done in the general area include Bonk (1990) Haun and Rosendahl (1985) and two previous surface examinations of this well site and vicinities by the author in 1990. Bonk did not locate cultural materials, Haun and Rosendahl identified possible prehistoric Hawaiian burial structures and remnant cultigens of ki, and kukui. The structures were located on the southeast summit of Heiheiahulu located to the southeast of the project area.

2. Identification of older bare pahoehoe flows, soil covered pahoehoe and a'a flows, kipuka and cinder cones and the project area. Holmes' (1985) map of lava flows (see map Figure #4) indicates that the project area is at the north extreme of an 1800's flow with a 750 to 1,000 BP flow north of the site. A recent 1961 flow occurred approximately 1 km to the west of the site. There is just one cinder cone in the vicinity which is located well outside the project area to the north.

3. Identification of cultigens. No aerial photographs were made available to us and hence we cannot offer any aerial interpretations of vegetation areas. However, we did not observe any cultivated plants such as banana, ki, or kukui in the research area.

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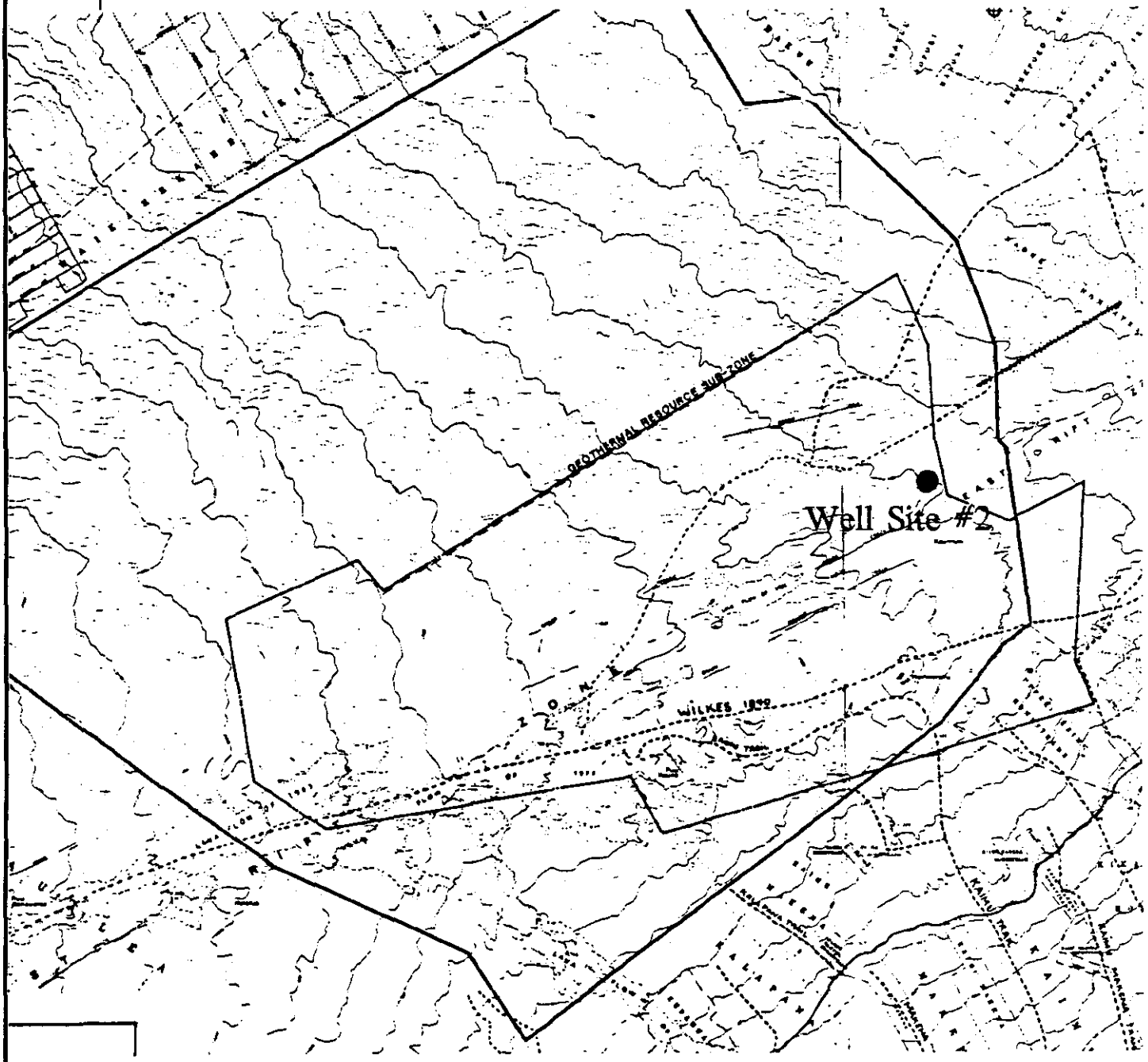

Figure 3.
Trail Location Map
(from Bonk, 1988)

Trails ----------

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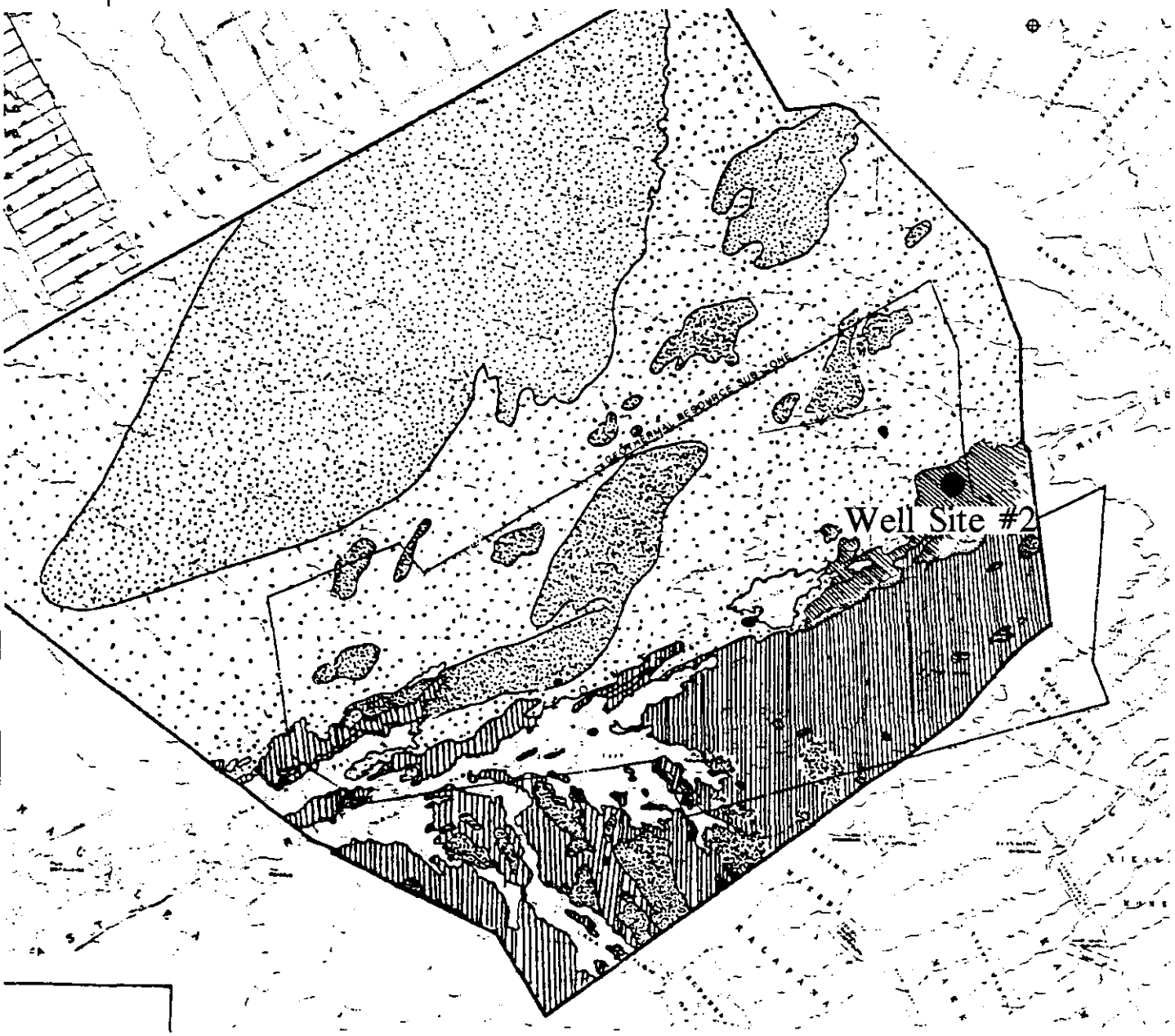


Figure 4.
Map of Lava Flows
(from Bonk, 1988)

1800 Flows |||||||

700-1000 BP Flows \\\\\\\

ARCHAEOLOGICAL SURFACE SURVEY: FINDINGS

1. Caves. The pahoehoe portions of the subject property featured numerous inflated dome type caves - in every case, these were found to be very shallow and devoid of any cultural indications. The largest of these inflated dome type caves observed was no more than 2 meters wide, approximately 3/4 meter high and 2 meters in depth. In comparison, the smallest cave observed was 1/2 meter wide by 1/2 meter high and 1 meter deep. A single, larger cave was encountered in the buffer zone. This measured roughly 12X15 feet and was eight feet high. It should be pointed out that a cave lacking cultural material is not considered an archaeological site. There was no cultural material encountered in any of the lave domes or in the single larger cave and therefore none of these geologic formations should be misinterpreted as sites.

The property also features a number of cracks. The smallest being one foot wide, three feet long and two feet deep. The largest is roughly 100 feet long, twenty feet wide with depths ranging between 25 and 40 feet. There is a cave entrance at the bottom of the largest crack, however, the area is very unstable, with loose, rotting rock and debris making even a rappelling exercise treacherous to the point of foolishness. There were no cinder cones within the project area.

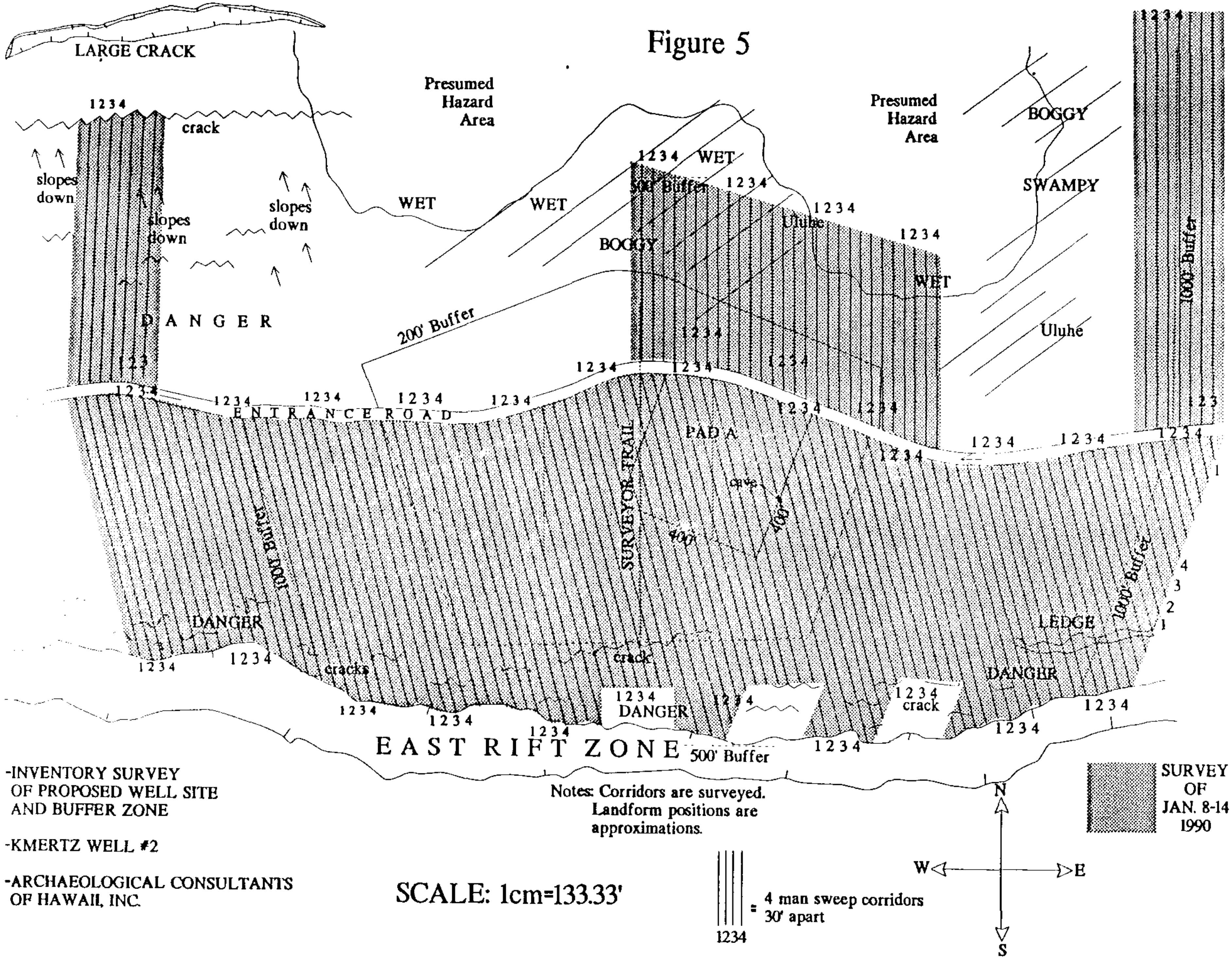
2. Kipuka Pahoehoe. There were no kipuka observed within the boundaries of the project area.

3. Trails. The Kaimu trail and the Wilkes expedition trail passed east-west approximately 3/4 to 1km to the south of the project area. The proximity of the Hawaiian trail suggests that an additional trail paralleling this one would be unlikely. However, the proximity may have increased the likelihood of prehistoric access to the project area.

4. Inventory Survey: Methodology. An intensive inventory survey was completed for the well pad as well as the buffer zone. A survey team, consisting of the four individuals mentioned previously, spaced roughly 30 feet apart, conducted a series of north/south compass transects sweeps across the entire property (see map Figure #5) -save three small areas along the southern boundary where entry was deemed too dangerous. These four individuals worked ten hours a day for six days to complete the survey.

It is estimated that 100% of the property was covered. While extremely thick vegetation limited visibility, survey crew members were in constant visual and radio contact with each other and it is our opinion that it is highly unlikely that any surface features or cave entrances were overlooked.

Figure 5



LARGE CRACK
crack
slopes down
slopes down
slopes down
Presumed Hazard Area
Presumed Hazard Area
WET
WET
WET
WET
BOGGY
BOGGY
SWAMPY
Uluhe
Uluhe
500' Buffer
200' Buffer
1000' Buffer
1000' Buffer
1000' Buffer
DANGER
ENTRANCE ROAD
PAD A
SURVEYOR TRAIL
cave
400'
400'
DANGER
LEDGE
cracks
crack
DANGER
DANGER
crack
EAST RIFT ZONE
500' Buffer
1234
-INVENTORY SURVEY OF PROPOSED WELL SITE AND BUFFER ZONE
-KMERTZ WELL #2
-ARCHAEOLOGICAL CONSULTANTS OF HAWAII, INC.
SCALE: 1cm=133.33'
Notes: Corridors are surveyed. Landform positions are approximations.
1234 = 4 man sweep corridors 30' apart
N
S
W
E
SURVEY OF JAN. 8-14 1990

FINDINGS IN GENERAL

Based on the direct observation of surface conditions along the sweep framework corridors, and on the evaluation of understory and canopy type along the periphery of these corridors, we conclude the following:

Mud, water, and thick accumulations of rotting vegetation prevented, in most cases, any direct contact with bare lava surfaces. The similarity between understory and canopy along the sweep corridors and that which was observed within an approximate 100' periphery leads us to conclude that surface conditions are the same in these outer areas as they are where we could see them directly. Therefore, the percentage of the study area underlain by pahoehoe and a'a, apparent differences in flow age and the distribution of these differences cannot be determined at this time.

The large cracks described earlier presented a hazard in all the corridor areas thus far established. However, in both the vicinity of the rift zone and the entire northwestern section of the buffer zone, deep cracks, steep slopes, and obscuring vegetation presented such extreme hazard that additional sweep corridors could not be established. The flatter northeast section of the buffer zone, as was determined from observations off the northeast corridor and the midsection probe, revealed the swampiest conditions encountered over the entire property, and plans for additional corridors were similarly abandoned.

No cultural indicators were located within the buffer area.

FINDINGS FOR WELL SITE AREA #2

No cultural indicators were located within the well site impact area. There were no sightings of any cultigens such as ki, banana, kukui, within the well site area.

DISCUSSION AND RECOMMENDATIONS

The prediction and identification of temporary forest shelter sites used hundreds of years ago by small groups such as bird feather collectors will be extremely difficult. The

illusive temporary campsites in this upland forest area can be expected to be either buried, random, or so lacking in diagnostic materials that archaeological identification and data recovery may be impossible or impractical unless camp sites used seasonally over many years are encountered. Hypothetically, two types of campsites may be possible in this area, a short term, one-time-used camp site or campsites which were set up along established travel routes and used year after year.

Presumed campsites have been found in lava tubes in forested areas on Campbell Estate Land. However, because no campsites have been identified, to date, in upland forests, our predictive model continues to be based on a shallow data base.

Archaeological monitoring of soil covered areas after initial grading and grubbing. We feel that a need for some form of monitoring during initial phases of grubbing and grading is important. Monitoring is recommended because of the known presence of lava tubes in the general area.

In addition, Archaeologists will be "on-call" if the 7-1/2 inch drill bit hits an "air void" indicating the possible presence of a cave. At that time, work will stop, the drill bit removed to facilitate the insertion of a fiber optic device to examine the void for cultural materials.

Also, as a special effort to try and identify subsurface remains of trail and forest exploitation, campsites and forest exploitation working areas, this monitoring should occur. It shall only be done in soil areas. The cuts made during grubbing and grading will be inspected to see if these sites can be identified.

The highest likelihood for locating and identifying campsites in the project area will be during the monitoring of vegetation clearing and earth moving. The presence of features such as developed stratigraphic layers, perishable midden accumulations (charcoal and lithic debris) and foundation outlines, should they exist within the project area, will best be tested during this next phase. In this case, standard excavation methods will be applied.

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TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA

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December 19, 1990

Mr. Manabu Tagomori, Deputy Director
Department of Land and Natural Resources
State of Hawaii
Kalanimoku Building, Room 227
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Tagomori:

In a letter to the department dated October 26, 1990, a supplemental archaeological report was forwarded to you. The report relates to additional archaeological field surveys that were accomplished in response to certain of the department's comments to an earlier survey dated September 6, 1990.

The two reports were done in connection with a proposed well site No.2 located approximately 4000' to the east of the current drill site (drill site No.1) along the access road into the project area.

The text of the supplemental report (dated October 26, 1990) refers to potential drill pads A and B. Both sites were marked on the ground by survey stakes placed by surveyors of Island Survey, Inc. Pad A is synonymous in identification with well site No.2. Pad B is a site that was marked to the west and adjacent to pad A as an alternative site in the event a greater buffer area was needed for a Hawaiian Hawk's nest found to the east of pad A. However, prior to the submittal of the first archaeological report on well site No.2 dated September 6, 1990, pad B was deleted from consideration due to the fact that the hawk's nest was no longer in use. The references to pad B were intended to be deleted from the reports but was inadvertently mentioned in the report dated October 26, 1990.

The field investigation referred to in both reports concern well site No.2 or pad A. Both the drawing of Nobuchika Santo, which refers to well site No.2 and the drawing of Archaeological Consultants of Hawaii (pad A), in the October 26th report, are the same site. Pad B as stated earlier, has been deleted from consideration. For your information, a separate field investigation was accomplished for pad B but the report was not

submitted to the department for consideration since well site No.2 or pad A was the primary selection.

Secondly, as a further point of clarification, the area marked in the field for well site No.2 (pad A), has boundaries of 400' x 400'. The drawing of Archaeological Consultants of Hawaii, Inc. in the October 26, 1990, report is not to scale and the size discrepancy between that drawing and the surveyor's drawing, is due to this reason. Again, the field reference points used as posted markers for the archaeological field work on well site No.2 (pad A) was marked as 400' x 400'. The boundaries of the buffer area were based upon these dimensions.

I hope that this letter serves to clarify any questions regarding the archaeological report of Archaeological Consultants of Hawaii, Inc.

Should you have any questions please call me at 528-3496.

Very Truly Yours

TRUE GEOTHERMAL ENERGY COMPANY
Allan G. Kawada

JOHN WAIHEE
GOVERNOR OF HAWAII

DRAFT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 South King Street, 6th Floor
Honolulu, Hawaii 96813

REF: HP-JE

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

Mr. Allan Kawada
True Geothermal Energy Company
220 South King Street, Suite 868
Honolulu, Hawaii 96813

Dear Mr. Kawada:

SUBJECT: Supplement to the Archaeological Survey Report for True/Mid-Pacific Geothermal Venture's Proposed Well Site #2 (KMERZ)
Former Puna Forest Reserve, Puna, Hawaii
TMK: 1-2-10: 3

Thank you for submitting the supplemental report (Ltr. Kennedy to Kawada, Oct. 26, 1990), to the archaeological inventory survey conducted for the proposed Geothermal Well Site #2. The letter report was written as a response to concerns expressed by the State Historic Preservation Division and presents the results of the archaeological survey which covered a more extensive buffer zone than the initial survey of Well Site #2 (Ltr. Kennedy to Kawada, Sept. 6, 1990).

Before discussing the archaeological survey itself, we wish to note the need to better clarify the location and description of the project under review. Inconsistencies appear to occur within this report and between this report and the initial one. It appears we are reviewing not only an addendum to the initial survey, but possibly an amended project plan. In order for us to adequately assess potential impacts of a project on historic resources, the project plans and any changes to them must be clearly and consistently stated either in the archaeological report or in attached documents. Changes in project plans can easily be accommodated by appropriate adjustments to our requirements or recommendations as long as we know specifically what the changes are. In this case it is particularly important that we know the exact location of the project area because the CDUA conditions and the required Research Design (Decision and Order of CDUA HA-1830, April 11, 1986), stipulate survey of specific buffer zones around areas that will be disturbed.

The major point of concern is the reference made on page 6 to "two proposed well pads (referred to as A and B on figure #4)." In what we assume is figure #4 (located between pages 7 and 8), only "Pad A" is shown and it does not appear to readily correspond to Well Site #2 which was described as the project area in the initial report. The statement, also on page 6, that the initial survey covered the two well pads, the proposed well site and a 200 foot buffer zone reinforces the impression that Pad A is not synonymous with Well Site #2. To add to the confusion the initial survey report mentions no well pads at all. In figure #4, the angle of Pad A to the east of the "Surveyor Trail" and the configuration of the marked "200' Buffer" suggest that a "Pad B" may have been located west of the "Surveyor Trail." If the scale on the map applies to pad size, then Pad A is approximately 250 by 250 feet. This would make one pad smaller than the 400 by 400 foot area given for Well Site #2 (Figure #3) but, if combined, the two pads would extend beyond these boundaries and cover an area larger than that designated in the initial survey.

It also appears that Pad A is off-set from the original configuration of Well Site #2 based on the locations of the four survey sweeps and the "Surveyor Trail" depicted in Figure #4. Presumably at least some of these lines mark the boundary or intersect Well Site #2 in the orignial survey. These discrepancies in size and location raise questions of the extent to which Well Site #2 and Pads A or B were marked at the time of field work. In order to be in compliance with the conditions of the CDUA permit, any area to be disturbed must be "clearly marked on-the-ground prior to any archaeological field work". Before any further work is done, we need a clear and accurate description of the project plans and clarification of how these plans relate to the survey work already completed.

As for the supplemental archaeological report, we feel that it adequately incorporates many of our concerns, particularly those regarding the description and depiction of the terrain and survey methods. We believe, however, that the survey coverage is not sufficient to demonstrate the probable absence of archaeological sites and in particular, lava tubes in the survey area. If we understand correctly, the survey corridors depicted in figure #4 served as the center line for survey sweeps along which a 50 foot wide area was inspected (20 feet to either side of the 10 foot wide corridor). This means that there was not 100% coverage of Pad A, the area to be directly impacted by well development. The overall dimensions of the buffer zone appear, despite confusion over the Well Site and Pad locations, to comply with our recommendation that the surveyed buffer zone measures 1,000 ft. up-slope and down-slope from the area to be disturbed and 500 feet to the northwest and southeast. We feel, however, that the spacing between the survey sweeps is too wide to provide the necessary coverage. Based on the described survey methods and figure #4, it appears that survey coverage amounts to only 18% of the buffer zone which lies south of the major access road and a possible 8% for the northern half. Some of these problems in survey coverage may have been avoided if the State Historic Preservation Division had been consulted before this supplemental survey was undertaken as required in the Research Design which was mandated by the CDUA permit.

We ask that another archaeological inventory survey be conducted which should include 100% coverage (or as close to 100% coverage as possible) of areas to be directly disturbed. Within the buffer zone, the present coverage needs to be at least doubled. Ground conditions can be hazardous and we realize that any survey strategy needs to take this into account. To avoid further delays in the review process for this project, we suggest that the survey strategy for this supplemental work be reviewed and accepted by the State Historic Preservation Division prior to field work. If this consultation is done in a meeting, it would be particularly important for at least one member of the field crew to attend so that the effects of hazardous field conditions on survey strategy can be assessed and the strategy adjusted. Our concurrance to proceed with initial grubbing and grading will be contingent on our review and acceptance of the report for this supplemental field work and any mitigation measures that might be necessary. It will also be subject to a field check.

There are also several mitigation measures that must be agreed upon before site preparation begins. These were discussed at our last meeting and it was agreed that all parties would give the recommendations further consideration. Included is the extent to which grubbing and grading must be monitored during initial ground disturbance and the way in which possible lava tubes or voids can be detected and explored if encountered during drilling.

If you have any questions on this review or you wish to discuss the unresolved mitigation measures, please contact Ross Cordy or Holly McEldowney at the State Historic Preservation Division (587-0047).

Very truly yours,

WILLIAM W. PATY
Chairperson and State
Historic Preservation Officer

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 South King Street, 6th Floor
Honolulu, Hawaii 96813

December 10, 1990

MEMORANDUM

TO: Manabu Tagomori, Deputy Director
Commission on Water Resource Management

FROM: Don Hibbard, Director, Historic Preservation Program

SUBJECT: Supplement to the Archaeological Survey Report for True/Mid-Pacific Geothermal Venture's Proposed Well Site #2 (KMERZ)
Former Puna Forest Reserve, Puna, Hawaii
TMK: 1-2-10: 3

HISTORIC PRESERVATION PROGRAM CONCERNS:

We have reviewed the letter report submitted by True Geothermal Company (Ltr. Kennedy to Kawada, Oct. 26, 1990). It supplements the archaeological inventory survey conducted earlier for Well Site #2 and, according to the cover letter, was undertaken in response to comments made by our staff. Our draft reply is attached for your review. As you can see, we continue to have problems with the archaeological survey and feel that we have not been given adequate or consistent project plans by which to evaluate certain aspects of the survey or the projects potential impacts.

Please contact either Ross Cordy or Holly McEldowney (587-0047) if you have any questions regarding the review or wish to suggest any changes before final processing by the Department.

TRUE GEOTHERMAL ENERGY COMPANY

90 NOV 2 P 4:20

CENTRAL PACIFIC PLAZA

Telephone No.: 808-528-3496
FAX No.: 808-526-1772
220 South King Street
Suite 868
Honolulu, HI 96813

DIV. OF WATER & LAND DEVELOPMENT

November 2, 1990

Mr. Manabu Tagomori
Deputy Director
Department of Land and Natural Resources
Kalanimoku Building, Room 227
1151 Punchbowl Street
Honolulu, Hawaii 96813

Subject: Supplement to Archaeological Report Regarding Proposed Well Site Number 2, KMERZ, Puna, Hawaii

Dear Mr. Tagomori:

Enclosed for your review and acceptance is the supplemental report for proposed well site number 2. I believe that the report addresses the Department's comments relating to the initial archaeological report on well site number 2.

The report describes the additional field surveys and transects that were accomplished in response to discussions with the Department's staff.

Should there be any questions regarding the report's contents, please do not hesistate to call me at 548-3496.

Sincerely,

Allan G. Kawada

TRUE GEOTHERMAL ENERGY COMPANY

AGK:jkk

Enclosure

Archaeological Consultants of Hawaii, Inc.
59-624 Pupukea Rd.
Haleiwa, Hawaii 96712

MAP 1

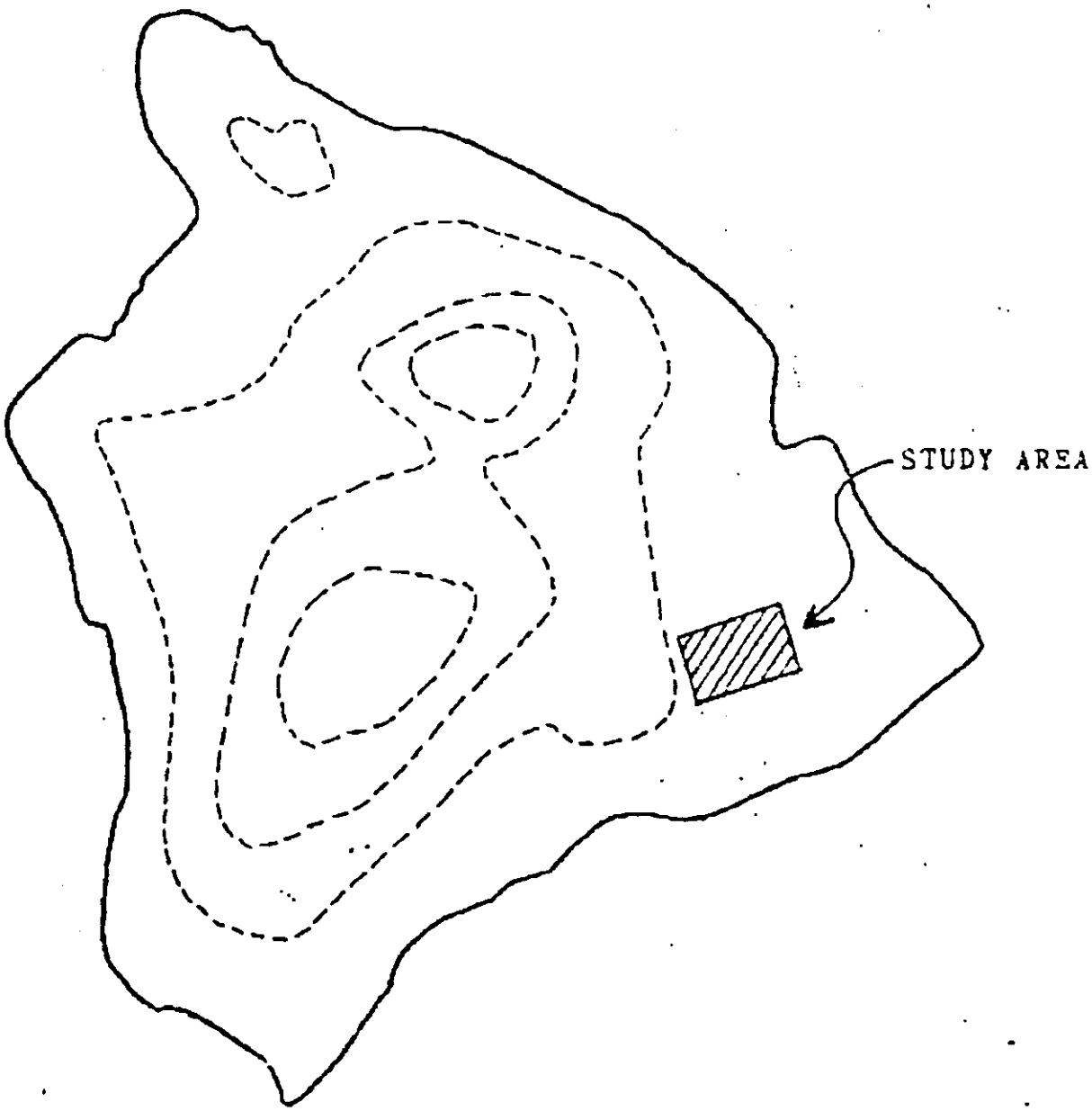


FIGURE 1

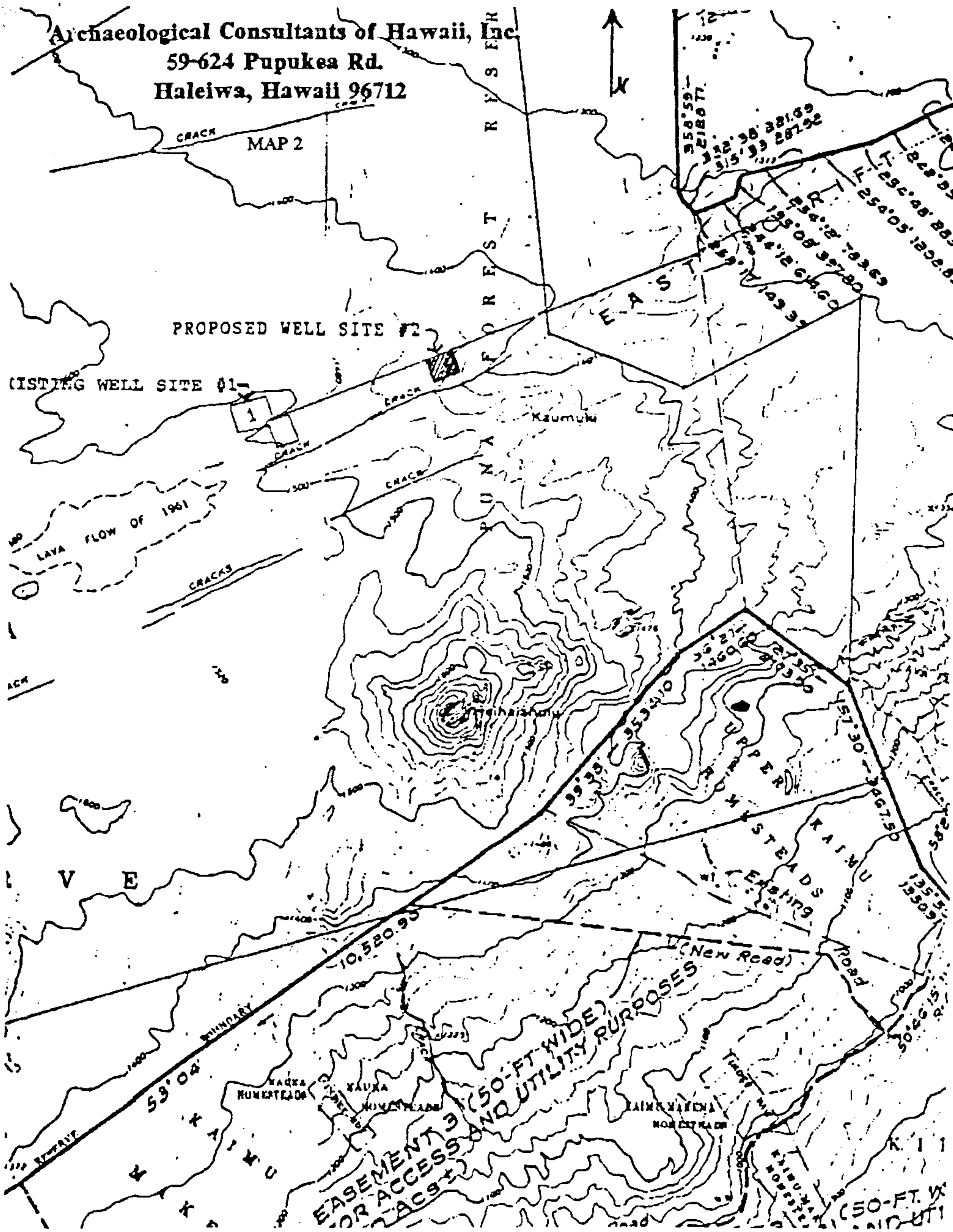

Archaeological Consultants of Hawaii, Inc.
59-624 Pupukea Rd.
Haleiwa, Hawaii 96712
MAP 2
PROPOSED WELL SITE #2
XISTING WELL SITE #1
CRACK
CRACKS
LAVA FLOW OF 1961
Kaumuki
EAST RIFT
PUNA FOREST RESERVE
UPPER KAIMU HOMESTEADS
(New Road)
Existing Road
EASEMENT 3 (50-FT. WIDE) FOR ACCESS AND UTILITY PURPOSES
10,520.95
BOUNDARY
KAIMU
MAUKA HOMESTEADS

FIGURE 2

PURPOSE OF WORK

A variety of archaeological sites may be expected in the vast forest lands where True/Mid-Pacific Geothermal Venture will be conducting its geothermal exploration activities. Although the sites' distribution generally will be sparse and although most project activities may well miss the sites, it is important to have adequate plans to identify historic sites, so the sites can be avoided or appropriately mitigated. Special identification problems exist in forest lands, and for this reason an archaeological research design for archaeological survey methods was required under CDUA HA-1830 as part of an archaeological plan.

PREHISTORIC AND EARLY HISTORIC LAND USE IN THE PROJECT AREA AND ANTICIPATED HISTORIC SITES

Historic and archaeological research in this area as well as in other similar environmental zones on Hawaii Island, indicate that prehistorically such areas were used for:

1. Forest product exploitation. Bird feathers, timber, vines, etc. were collected in the forests at or near worksites, and campsites were nearby. These sites should be scattered around much of the project area, in low densities for any one point in prehistory.

2. Burial. These sites are expected to be focused in certain areas.

3. Major inland trails across many ahupua'a and associated campsites. These sites should be focused in linear corridors.

4. Agriculture in the seaward-most reaches. These sites may tend to be fairly dense but they will again be in a small part of the project area, in the seaward portions.

Archaeologically, the sites should have the following characteristics:

1. Forest exploitation sites. Probably there will be no surface stone architecture (huts and shelters likely were simply pole and thatch). Some campsites will be in caves. Each site may be a small scatter of flaked stone, broken tools, food remains (bone, shell), and firepits. If repeated use occurred, then the density of remains would be greater.
   Such campsites are documented in caves in forest areas. Such cave campsites have yielded a great deal of important information on the age of use of an area, on birds and plants collected. etc. Campsites and exploitation sites have yet to be documented in open-air context, and in such cases, they are expected to primarily be subsurface, buried sites.

2. Burials. Burials in forest areas have been identified in two forms --burials in caves (often caves also used as campsites) and in stone platforms and pavings on cinder cones. These sites contain important information on age of permanent occupation in an area, on social organization, on health, on demography. Additionally, they are highly significant sites culturally for native Hawaiians.

3. Trails. Trails in forest areas are expected to be extremely difficult to identify, as worn paths and cuts through the forest will have been covered over by later sediments and by forest regrowth. On bare a'a flows, there will be some visible features -- e.g., crushed paths, stepping stones. Campsites along the trails should have firepits, food remains, and some scattered artifacts. Some campsites may have been in caves, but others will have been open-air camps, and may have no surface architecture and be buried like the forest exploitation camps. Trails and their associated campsites can tell us a great deal about the nature of different time periods of travel across regions. Trails also provide information on items being carried or exchanged.

4. Agricultural sites. These sites commonly have some kind of stone-work --small oval clearings lined with stones, small terrace lines, walls, etc. These sites contain important chronological information on permanent settlement of an area, population expansion, and agricultural expansion.

SITE IDENTIFICATION PROBLEMS

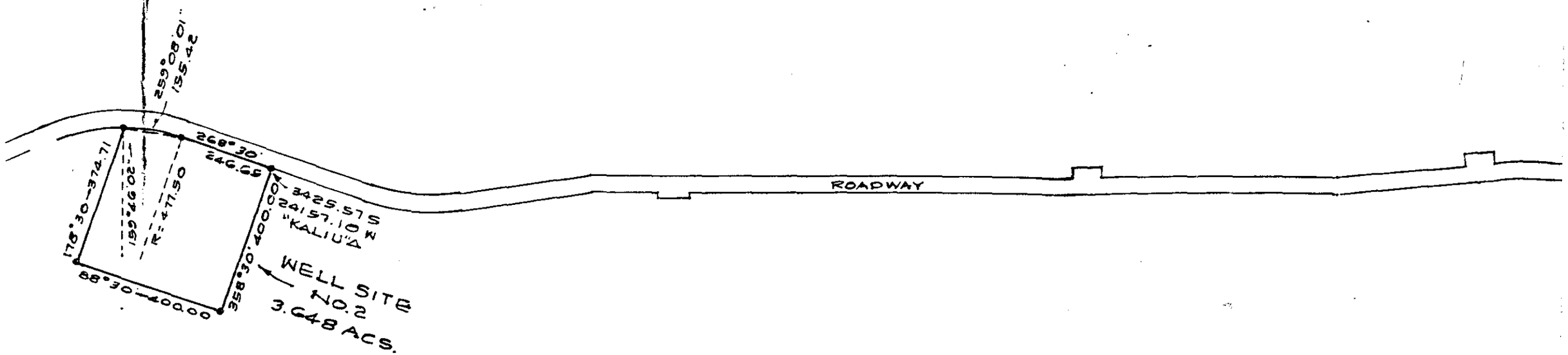
Common archaeological surface survey (labelled reconnaissance survey, intensive survey, etc.) can identify cave sites used for forest exploitation and/or burial, can identify agricultural sites, and can identify trails on bare a'a flows. However, cave sites are only expected in older pahoehoe areas, not on a'a flows and not in recent pahoehoe areas. Platform and paving burial sites are expected to be restricted to cinder cones. Agricultural sites will be at lower, seaward elevations in areas with soil. This means that a'a flows and recent pahoehoe flows are not expected to include sites unless there is a visible trail remnant.

The open-air sites in forest areas -- trail sites (and there associated camps) and forest exploitation sites (not in caves) -- will likely be subsurface. They will also be small. Common surface survey will not be able to identify these sites when they are subsurface. These sites are expected in soil areas within kipuka, and on old pahoehoe flows, and on older a'a flows lacking rough surfaces.
These sites may be surface remains on bare lava in kipuka, on old pahoehoe flows and on older a'a flows lacking rough surfaces and in such a case common surface survey could identify them; but it appears unlikely that these sites will be found on the surface.

They are not anticipated on rough a'a flows (except rare trails) or on recent pahoehoe or a'a flows. The above problems indicate two special conditions for site identification;

1. Some areas appear not to need survey. - - e.g., rough a'a flows and recent lava flows (post 1880 flows whether pahoehoe or a'a) these areas need to be identified and be clearly marked off as areas needing no archaeological work.

2. Soil areas may contain subsurface exploitation and trail related sites. Special archaeological approaches need to be devised for these areas to try and identify these sites.



SHOWING
OF
AS OF PARCEL B
BEEN LAID OUT WITHIN THE BOUNDARIES
PEELL, DECEASED
HELD KAAPUNI AT HONOKAA
OF HAWAII, HAWAII

YOBUCHIKA SANTO
REGISTERED
PROFESSIONAL
LAND
SURVEYOR
No. 1343
HAWAII, U.S.A.

Yobuchika Santo

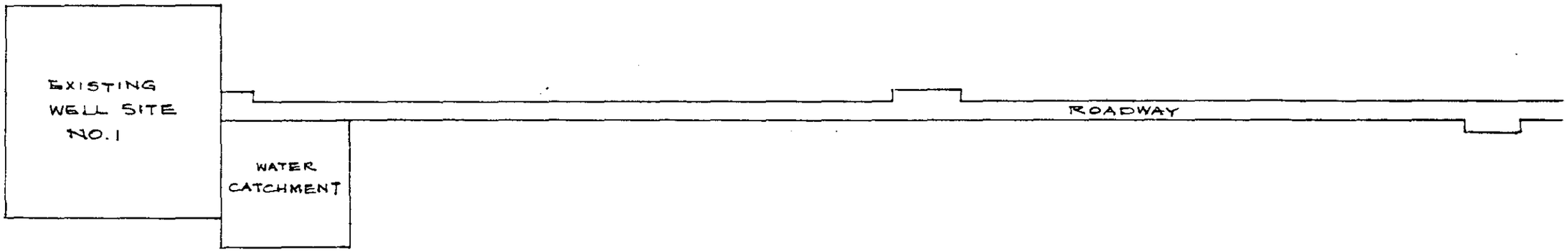


FIGURE 3

SURVEY AND PLAN BY ELLAIS SURVEY NO.
P.O.BOX 37, HILO, HAWAII

AUGUST 29, 1990

BEING R
PORTION OF GRANT [illegible] TO
OF JAMES

MAKUU, KAOHE, KAIM
PUNA, ISL

ARCHAEOLOGICAL CONSULTANTS
of
HAWAII

59-624 Pupukea Rd.
Haleiwa, Hawaii 96712
(808) 638-7442

JOSEPH KENNEDY
Archaeologist

Mr. Alan Kawada
True Mid Pacific Geothermal
Central Pacific Plaza Suite 868
220 South King
Honolulu, Hawaii 96813

October 26, 1990

Dear Mr. Kawada:

This letter addresses the concerns of the State Historic Preservation Office, their comments concerning my report of September 6, 1990 and the findings of our additional survey work conducted approximately two weeks ago.

INTRODUCTION AND PHYSICAL SETTING

At the request of your office, Archaeological Consultants of Hawaii, Inc. has conducted an inventory survey at the site of the proposed Kilauea Middle East Rift Zone (KMERZ), Well Site #2, TMK: 1-2-10:3. An additional inventory survey was conducted to encompass a 1,000 foot buffer zone around the site of the proposed Well Site #2. This proposed well site is located in the Wao Kele O Puna Forest, Island of Hawaii (see maps #1 and 2).

The subject property features an extremely rugged topography and an unusually thick vegetatative profile which combine to present some of the most difficult survey areas in the state. A thick mat of stony muck rests on what appears to be alternating a'a and pahoehoe and is covered with very dense uluhe, 'ie'ie, hapu'u, guava, ohi'a and a number of additional plants, vines and grasses. The reader may wish to refer to the numerous and recently completed botanical studies of this area for a more complete listing.

BACKGROUND PREPARATION; FINDINGS

1. Check of historic and archaeological literature. The historic literature (Holmes 1985) shows no recorded trails in the project area. The Wilkes route of 1840 (see map number 3) passes to the south of the project area and the Kaimu Trail, approximately .75km to the south skirts south of Heiheiahulu. The existence of the existing Kaimu Trail lowers the probability of an additional trail passing through the study area but increases the possibility that the area was accessed prehistorically.

Previous archaeological surveys done in the general area include Bonk (1990) Haun and Rosendahl (1985). Bonk did not locate cultural materials, Haun and Rosendahl identified possible prehistoric Hawaiian burial structures and remnant cultigens of ki, and kukui. The structures were located on the southeast summit of Heiheiahulu located to the southeast of the project area.

2. Identification of older bare pahoehoe flows, soil covered pahoehoe and a'a flows, kipuka and cinder cones and the project area. Holmes' (1985) map of lava flows (see map #4) indicates that the project area is at the north extreme of an 1800's flow with a 750 to 1,000 BP flow north of the site. A recent 1961 flow occurred approximately 1 km to the west of the site. There is just one cinder cone in the vicinity which is located well outside the project area to the north.

3. Identification of cultigens. No aerial photographs were made available to us and hence we cannot offer any aerial interpretations of vegetation areas. However, we did not observe any cultivated plants such as banana, ti, or kukui in the research area.

ARCHAEOLOGICAL SURFACE SURVEY: FINDINGS

1. Caves. The pahoehoe portions of the subject property featured numerous inflated dome type caves - in every case, these were found to be very shallow and devoid of any cultural indications. The largest cave observed was no more than 2 meters wide, approximately 3/4 meter high and 2 meters in depth. In comparison, the smallest cave observed was 1/2 meter wide by 1/2 meter high and 1 meter deep. The property also features a number of cracks. The smallest being one foot wide, three feet long and two feet deep. The largest is roughly 100 feet long, twenty feet wide with depths ranging between 25 and 40 feet. There is a cave entrance at the bottom of the largest crack, however, the area is very unstable, with loose, rotting, rock and debris making even a rappelling exercise treacherous to the point of foolishness. There were no cinder cones within the project area.

2. Kipuka Pahoehoe. There were no kipuka observed within the boundaries of the project area.

3. Trails. The Kaimu trail and the Wilkes expedition trail passed east-west approximately 3/4 to 1km to the south of the project area. The proximity of the Hawaiian trail suggests that an additional trail paralleling this one would be unlikely. However, the proximity may have increased the likelihood of prehistoric access to the project area.

4. Reconnaissance Survey: Methodology. A walkthrough reconnaissance survey was completed for the area identified as two proposed well pads (referred to as A and B on figure #4), the proposed well site #2, and an accompanying 200 foot buffer zone. A second walkthrough reconnaissance survey was completed for a buffer zone of 1,000 feet around the proposed well site described above. In other words, the second survey extended the buffer zone an additional 800 feet.

The first survey area was located primarily on the south side of the main entrance road, extending toward the east rift zone. The second survey area for the buffer zone took us into that property which lies south of the entrance road and the north side of the road.

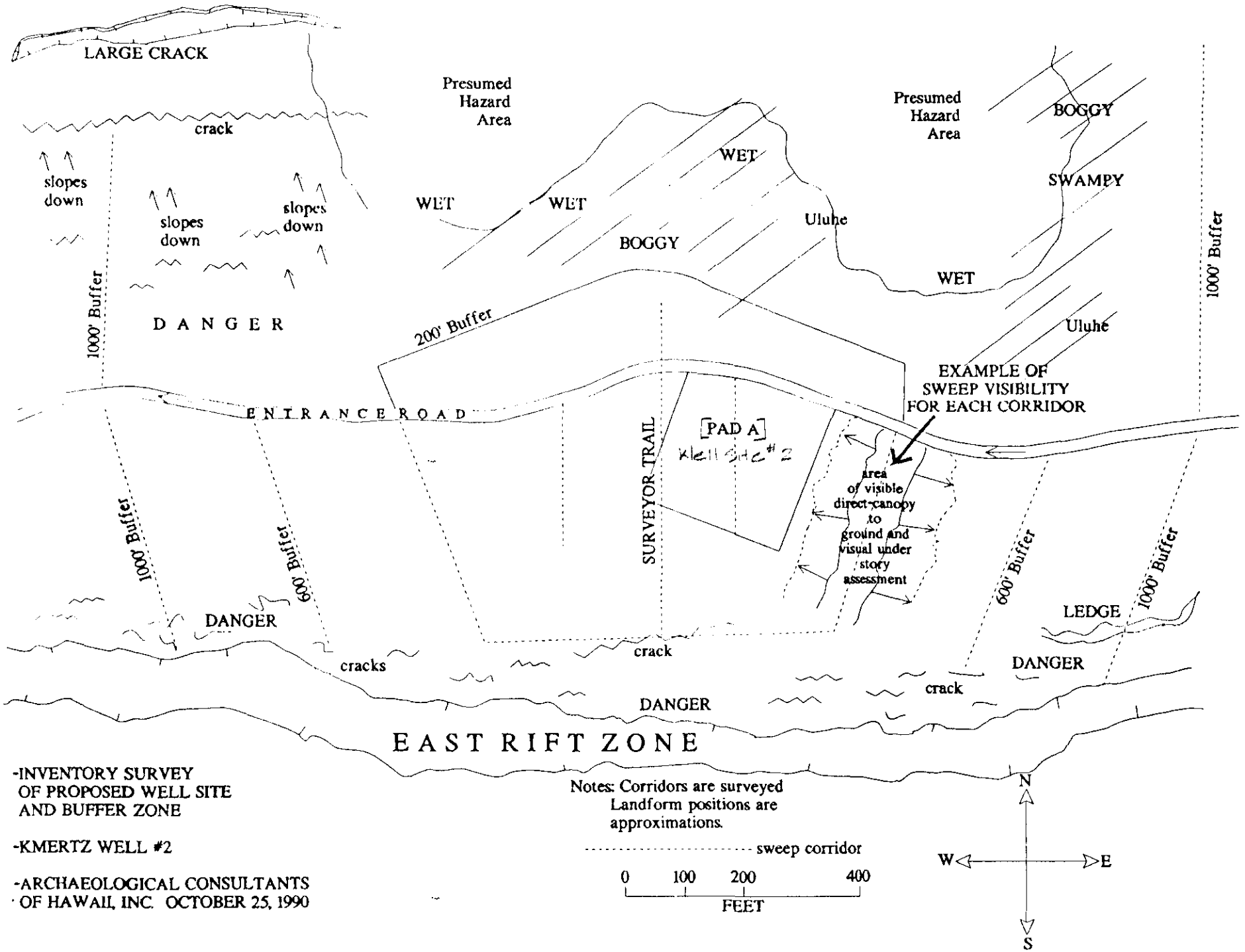
Our initial survey was completed by two individuals who worked for two full days ten hours per day. The second survey was completed by the same two individuals and one assistant for cutting trails and tape measuring. The team worked five hours a day for three days.

The survey team for the initial survey cut a series of four access corridors into the south portion of the property. These extended in a southerly direction toward the east rift zone, at approximate right angles to the main entrance road. Another trail, probably established by Island Survey, provided additional access midway between the corridors established by the ACH team. The team also cut an access corridor at a right angle to the four southerly extending corridors, in the easternmost explorable area. (Please refer to Figure #4).

The survey team for the second survey cut a series of six additional access corridors; two were cut at intervals of 600 feet and 1000 feet on each side of the well pads. These four corridors extended in an easterly direction toward the rift zone. The remaining two corridors were cut into the forest on the north side of the road, 1000 feet out from the corners of the well pads. The team also explored the feasibility of adding another corridor directly opposite the well pads to the north, but surface conditions were deemed too hazardous to continue. (Again, please refer to Figure #4)

These corridors provided a sweep framework for the survey area. We estimate that visual assessment of surface conditions was maintained for a width of no more than twenty feet to each side of each corridor, whose width is estimated to be approximately ten feet, or the average distance between the two team members as they traveled the corridor.

The entire area surveyed is comprised of bog and swamp, dominated by a mixed mesic-type rainforest of 'ohi'a, hapu'u, Kilauea hepyotis, and assorted epiphytic vegetation such as mosses, ferns, and 'ala'alawainui. The majority of 'ohi'a appears to be stunted, probably a result of the boggy conditions. Included to a lesser degree are 'akala, guava, waiawi, 'ie'ie, maile, mamaki, kolea, assorted gingers (mostly 'awapuhi), occasional fleabane, bamboo orchid, iris and lobelia. The roadway bulldozer push (approximately 25 feet on either side) consists mostly of fleabane, mamaki, 'akala, bamboo orchid, iris, guava, a species of melastoma candida, and other exotics.


LARGE CRACK
crack
slopes down
slopes down
slopes down
1000' Buffer
DANGER
Presumed Hazard Area
WET
WET
WET
BOGGY
Uluhe
Presumed Hazard Area
BOGGY
SWAMPY
WET
Uluhe
1000' Buffer
200' Buffer
ENTRANCE ROAD
SURVEYOR TRAIL
PAD A
Kmertz Site # 2
EXAMPLE OF SWEEP VISIBILITY FOR EACH CORRIDOR
area of visible direct canopy to ground and visual under story assessment
1000' Buffer
600' Buffer
DANGER
cracks
crack
DANGER
crack
600' Buffer
LEDGE
1000' Buffer
DANGER
EAST RIFT ZONE
-INVENTORY SURVEY OF PROPOSED WELL SITE AND BUFFER ZONE
-KMERTZ WELL #2
-ARCHAEOLOGICAL CONSULTANTS OF HAWAII, INC. OCTOBER 25, 1990
Notes: Corridors are surveyed
Landform positions are approximations.
sweep corridor
0 100 200 400
FEET
N
W
E
S

The land mass appears to be mostly pahoehoe, deduced indirectly by the smoothness of the surface and poor drainage conditions of this surface. Small outcrops of a'a were also observed. The pahoehoe is covered with either mud and water, mosses, or a mixture of all three. The mud, soil, and decayed vegetation occurred at a depth of approximately one foot. The mud areas have all been used extensively by pigs, as is evidenced by rooting digging, and chewed hapu'u. In areas in which there are fallen 'ohi'a and/or hapu'u, there are few, if any, caves of any consequence or size. Another observation was the lack of birds. We encountered only a few cardinals, a few finches or sparrows (limited visibility hampered identification). Notably absent is the presence of mongoose.

FINDINGS IN GENERAL

Based on the direct observation of surface conditions along the sweep framework corridors, and on the evaluation of understory and canopy type along the periphery of these corridors, we conclude the following:

Mud, water, and thick accumulations of rotting vegetation prevented any direct contact with bare lava surfaces. The similarity between understory and canopy along the sweep corridor and that which was observed within an approximate 100' periphery leads us to conclude that surface conditions are the same in these outer areas as they are where we could see them directly. Therefore, the percentage of the study area underlain by pahoehoe and a'a, apparent differences in flow age and the distribution of these differences cannot be know at this time.

The large cracks described earlier presented a hazard in all the corridor areas thus far established. However, in both the vicinity of the rift zone and the entire northwestern section of the buffer zone, deep cracks, steep slopes, and obscuring vegetation presented such extreme hazard that additional sweep corridors could not be established. The flatter northeast section of the buffer zone, as was determined from observations off the northeast corridor and the midsection probe, revealed the swampiest conditions encountered over the entire property, and plans for additional corridors were similarly abandoned.

No cultural indicators were located within the buffer area.

FINDINGS FOR WELL SITE AREA #2

No cultural indicators were located within the well site impact area. There were no sightings of any cultigens such as ki, banana, kukui, within the well site area.

DISCUSSION AND RECOMMENDATIONS

The prediction and identification of temporary forest shelter sites used hundreds of years ago by small groups such as bird feather collectors will be extremely difficult. The illusive temporary campsites in this upland forest area can be expected to be either buried, random, or so lacking in diagnostic materials that archaeological identification and data recovery may be impossible or impractical unless camp sites used seasonally over many years are encountered. Hypothetically, two types of campsites may be possible in this area, a short term, one-time-used camp site or campsites which were set up along established travel routes and used year after year.

Presumed campsites have been found in lava tubes in forested areas on Campbell Estate Land. However, because no campsites have been identified, to date, in upland forests, our predictive model continues to be based on a shallow data base.

Archaeological monitoring of soil covered areas after initial grading and grubbing. We feel that a need for some form of monitoring during initial phases of grubbing and grading is important. Monitoring is recommended because of the known presence of lava tubes in the general area.

In addition, Archaeologists will be "on-call" if the 7-1/2 inch drill bit hits an "air void" indicating the possible presence of a cave. At that time, work will stop, the drill bit removed to facilitate the insertion of a fiber optic device to examine the void for cultural materials.

Also, as a special effort to try and identify subsurface remains of trail and forest exploitation, campsites and forest exploitation working areas, this monitoring should occur. It shall only be done in soil areas. The cuts made during grubbing and grading will be inspected to see if these sites can be identified.

The highest likelihood for locating and identifying campsites in the project area will be during the monitoring of vegetation clearing and earth moving. The presence of features such as developed stratigraphic layers, perishable midden accumulations (charcoal and lithic debris) and foundation outlines, should they exist within the project area, will best be tested during this next phase. In this case, standard excavation methods will be applied.

If there are any questions regarding this report, please feel free to contact us.

Aloha,

Joseph Kennedy
Consulting Archaeologist

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State of Hawaii
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Water Resource Management
Honolulu, Hawaii

NOV 19 1990

MEMORANDUM

TO: Mr. Don Hibbard, Director
Historic Preservation Division

FROM: Manabu Tagomori, Deputy Director

SUBJECT: Supplement to the Archaelogical Survey for True/Mid-Pacific Geothermal Venture's Proposed Well Site #2

Transmitted herewith for your review and acceptance is the supplemental report for the Archaeological Survey submitted by True/Mid-Pacific Geothermal Venture (applicant) for its proposed Geothermal Well Site #2. Maps within the report identify the distribution of the survey sweeps conducted for the proposed drill site, and the metes and bounds description of the site in relation to the existing geothermal well True/Mid-Pacific A1-1.

The survey supplement, prepared in response to your Division's request for additional information, was submitted by the applicant to the Department for approval. As such, we respectfully request your review of the enclosed documents and your drafting of a response to the applicant from the Department.

Please transmit your draft reply to our Division of Water Resource Management for review and final processing by the Department. A file copy of any correspondence concerning the above survey will be forwarded to you for your files. Should you have any questions, please contact me directly at Ext. 8-7533.

Thank you for your continued assistance.

DN:GSM:ko

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

NOV 1 1990

REF:WRM-MH

Mr. Allan G. Kawada
True Geothermal Energy Company
220 South King Street, Suite 868
Honolulu, Hawaii 96813

Dear Mr. Kawada:

The Department of Land and Natural Resources hereby approves your submitted ornithological and botanical surveys for proposed Well Site #2 and Alternate Well Sites #2 and #3. We have also reviewed your letter of October 4, 1990 and have no objections to your planned semi-annual bird surveys or the periodic quarterly botanical monitoring for areas proposed for development.

We would also like to advise you that your revised weed monitoring and biological management plan is currently under review and you will be notified upon completion of our evaluation. Should you have any questions, please contact Manabu Tagomori, Deputy Director, at 548-7533.

Very truly yours,

WILLIAM W. PATY

ARCHAEOLOGICAL CONSULTANTS
of
HAWAII

59-624 Pupukea Rd.
Haleiwa, Hawaii 96712
(808) 638-7442

JOSEPH KENNEDY
Archaeologist

Mr. Alan Kawada
True Mid Pacific Geothermal
Central Pacific Plaza Suite 868
220 South King
Honolulu, Hawaii 96813

October 26, 1990

Dear Mr. Kawada:

This letter addresses the concerns of the State Historic Preservation Office, their comments concerning my report of September 6, 1990 and the findings of our additional survey work conducted approximately two weeks ago.

INTRODUCTION AND PHYSICAL SETTING

At the request of your office, Archaeological Consultants of Hawaii, Inc. has conducted an inventory survey at the site of the proposed Kilauea Middle East Rift Zone (KMERZ), Well Site #2, TMK: 1-2-10:3. An additional inventory survey was conducted to encompass a 1,000 foot buffer zone around the site of the proposed Well Site #2. This proposed well site is located in the Wao Kele O Puna Forest, Island of Hawaii (see maps #1 and 2).

The subject property features an extremely rugged topography and an unusually thick vegetatative profile which combine to present some of the most difficult survey areas in the state. A thick mat of stony muck rests on what appears to be alternating a'a and pahoehoe and is covered with very dense uluhe, 'ie'ie, hapu'u, guava, ohi'a and a number of additional plants, vines and grasses. The reader may wish to refer to the numerous and recently completed botanical studies of this area for a more complete listing.

Archaeological Consultants of Hawaii, Inc.
59-624 Pupukea Rd.
Haleiwa, Hawaii 96712

MAP 1

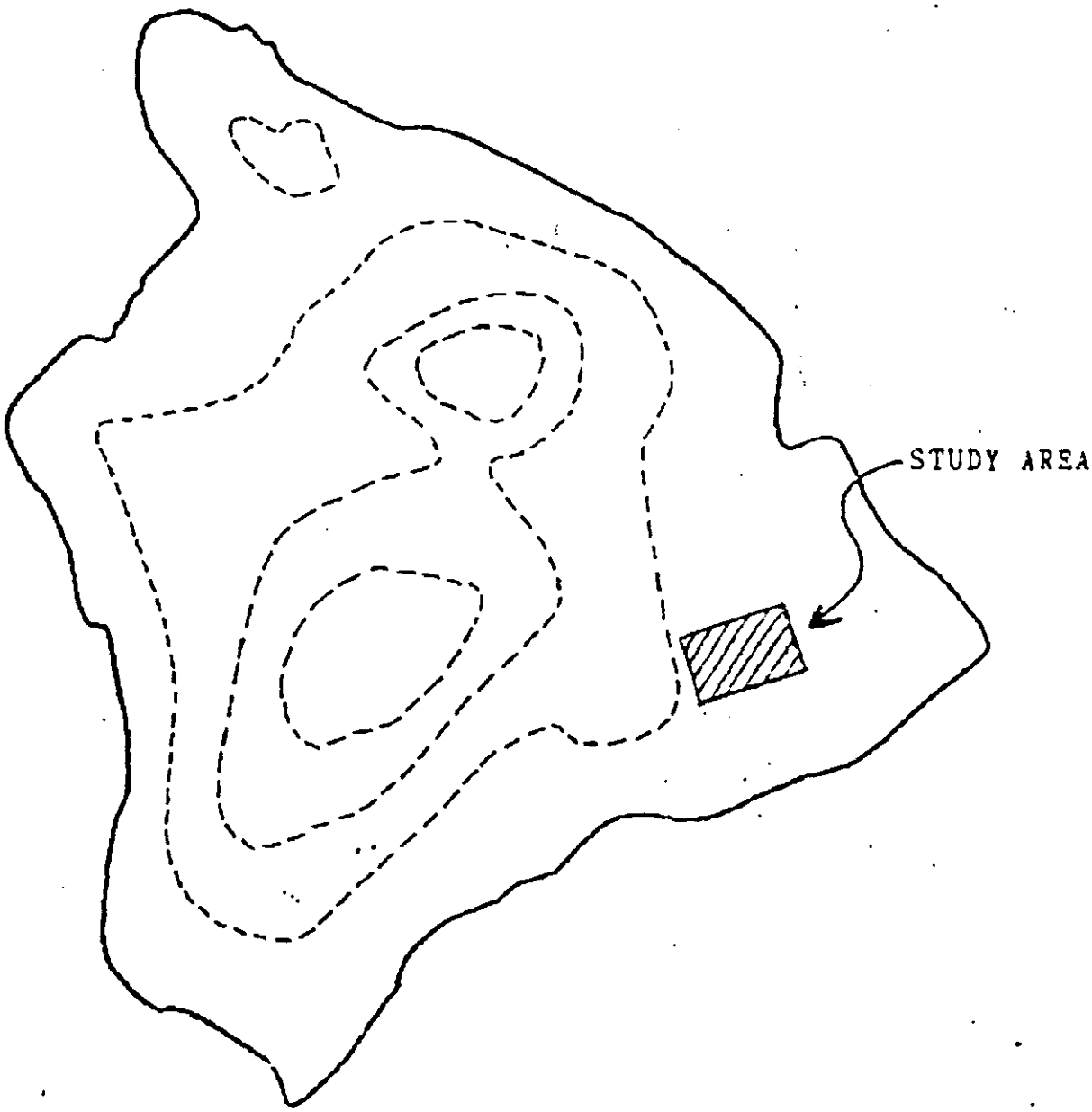


FIGURE 1

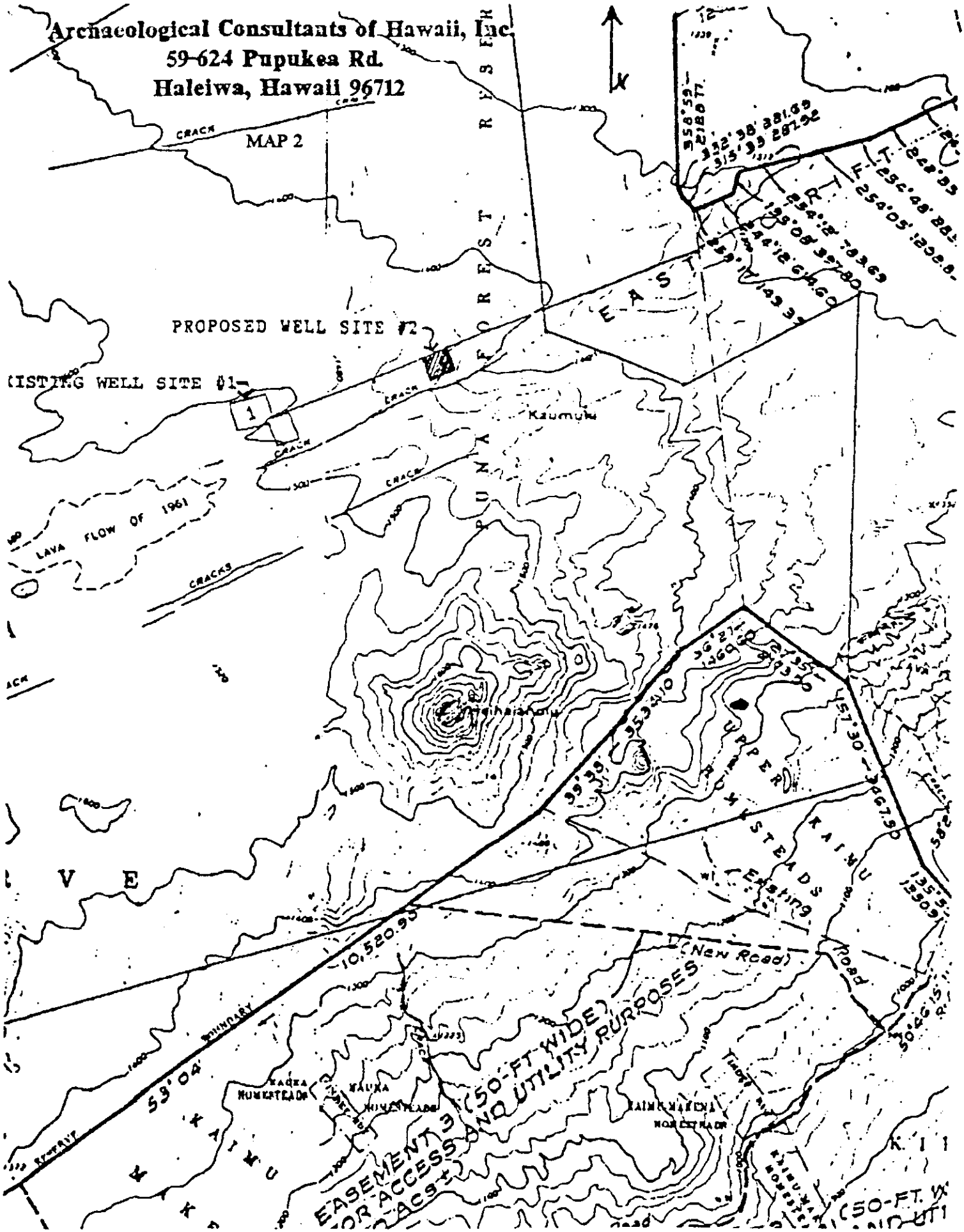

Archaeological Consultants of Hawaii, Inc.
59-624 Pupukea Rd.
Haleiwa, Hawaii 96712
MAP 2
PROPOSED WELL SITE #2
EXISTING WELL SITE #1
1
CRACK
LAVA FLOW OF 1961
CRACKS
Kaumuku
EAST RIFT
PUNA
UPPER PUKAPUKA HOMESTEADS
Existing Road
(New Road)
10,520.93
EASEMENT 3 (50-FT WIDE) FOR ACCESS AND UTILITY PURPOSES
KAUKA HOMESTEAD
KAUKA HOMESTEAD
KAIMU MAKENA HOMESTEAD
BOUNDARY
KAIMU
KAHUKU

FIGURE 2

PURPOSE OF WORK

A variety of archaeological sites may be expected in the vast forest lands where True/Mid-Pacific Geothermal Venture will be conducting its geothermal exploration activities. Although the sites' distribution generally will be sparse and although most project activities may well miss the sites, it is important to have adequate plans to identify historic sites, so the sites can be avoided or appropriately mitigated. Special identification problems exist in forest lands, and for this reason an archaeological research design for archaeological survey methods was required under CDUA HA-1830 as part of an archaeological plan.

PREHISTORIC AND EARLY HISTORIC LAND USE IN THE PROJECT AREA AND ANTICIPATED HISTORIC SITES

Historic and archaeological research in this area as well as in other similar environmental zones on Hawaii Island, indicate that prehistorically such areas were used for:

1. Forest product exploitation. Bird feathers, timber, vines, etc. were collected in the forests at or near worksites, and campsites were nearby. These sites should be scattered around much of the project area, in low densities for any one point in prehistory.

2. Burial. These sites are expected to be focused in certain areas.

3. Major inland trails across many ahupua'a and associated campsites. These sites should be focused in linear corridors.

4. Agriculture in the seaward-most reaches. These sites may tend to be fairly dense but they will again be in a small part of the project area, in the seaward portions.

Archaeologically, the sites should have the following characteristics:

1. Forest exploitation sites. Probably there will be no surface stone architecture (huts and shelters likely were simply pole and thatch). Some campsites will be in caves. Each site may be a small scatter of flaked stone, broken tools, food remains (bone, shell), and firepits. If repeated use occurred, then the density of remains would be greater.
   Such campsites are documented in caves in forest areas. Such cave campsites have yielded a great deal of important information on the age of use of an area, on birds and plants collected. etc. Campsites and exploitation sites have yet to be documented in open-air context, and in such cases, they are expected to primarily be subsurface, buried sites.

2. Burials. Burials in forest areas have been identified in two forms --burials in caves (often caves also used as campsites) and in stone platforms and pavings on cinder cones. These sites contain important information on age of permanent occupation in an area, on social organization, on health, on demography. Additionally, they are highly significant sites culturally for native Hawaiians.

3. Trails. Trails in forest areas are expected to be extremely difficult to identify, as worn paths and cuts through the forest will have been covered over by later sediments and by forest regrowth. On bare a'a flows, there will be some visible features -- e.g., crushed paths, stepping stones. Campsites along the trails should have firepits, food remains, and some scattered artifacts. Some campsites may have been in caves, but others will have been open-air camps, and may have no surface architecture and be buried like the forest exploitation camps. Trails and their associated campsites can tell us a great deal about the nature of different time periods of travel across regions. Trails also provide information on items being carried or exchanged.

4. Agricultural sites. These sites commonly have some kind of stone-work --small oval clearings lined with stones, small terrace lines, walls, etc. These sites contain important chronological information on permanent settlement of an area, population expansion, and agricultural expansion.

SITE IDENTIFICATION PROBLEMS

Common archaeological surface survey (labelled reconnaissance survey, intensive survey, etc.) can identify cave sites used for forest exploitation and/or burial, can identify agricultural sites, and can identify trails on bare a'a flows. However, cave sites are only expected in older pahoehoe areas, not on a'a flows and not in recent pahoehoe areas. Platform and paving burial sites are expected to be restricted to cinder cones. Agricultural sites will be at lower, seaward elevations in areas with soil. This means that a'a flows and recent pahoehoe flows are not expected to include sites unless there is a visible trail remnant.

The open-air sites in forest areas -- trail sites (and there associated camps) and forest exploitation sites (not in caves) -- will likely be subsurface. They will also be small. Common surface survey will not be able to identify these sites when they are subsurface. These sites are expected in soil areas within kipuka, and on old pahoehoe flows, and on older a'a flows lacking rough surfaces.
These sites may be surface remains on bare lava in kipuka, on old pahoehoe flows and on older a'a flows lacking rough surfaces and in such a case common surface survey could identify them; but it appears unlikely that these sites will be found on the surface.

They are not anticipated on rough a'a flows (except rare trails) or on recent pahoehoe or a'a flows. The above problems indicate two special conditions for site identification;

1. Some areas appear not to need survey. - - e.g., rough a'a flows and recent lava flows (post 1880 flows whether pahoehoe or a'a) these areas need to be identified and be clearly marked off as areas needing no archaeological work.

2. Soil areas may contain subsurface exploitation and trail related sites. Special archaeological approaches need to be devised for these areas to try and identify these sites.

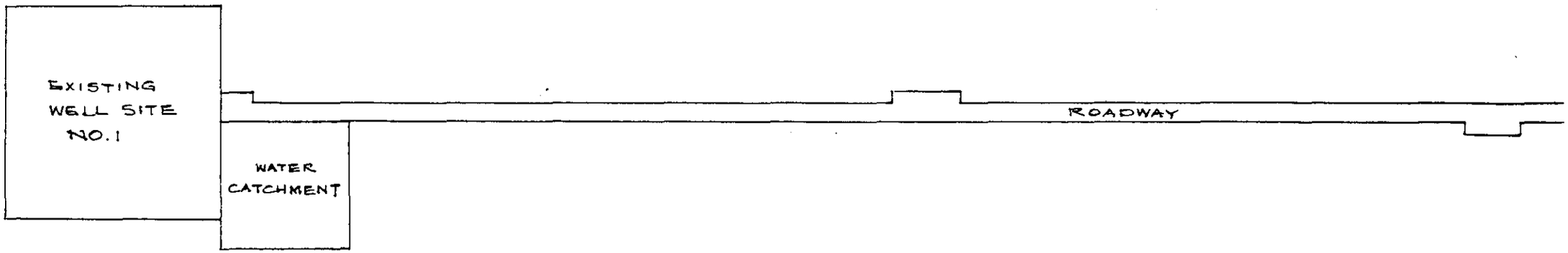


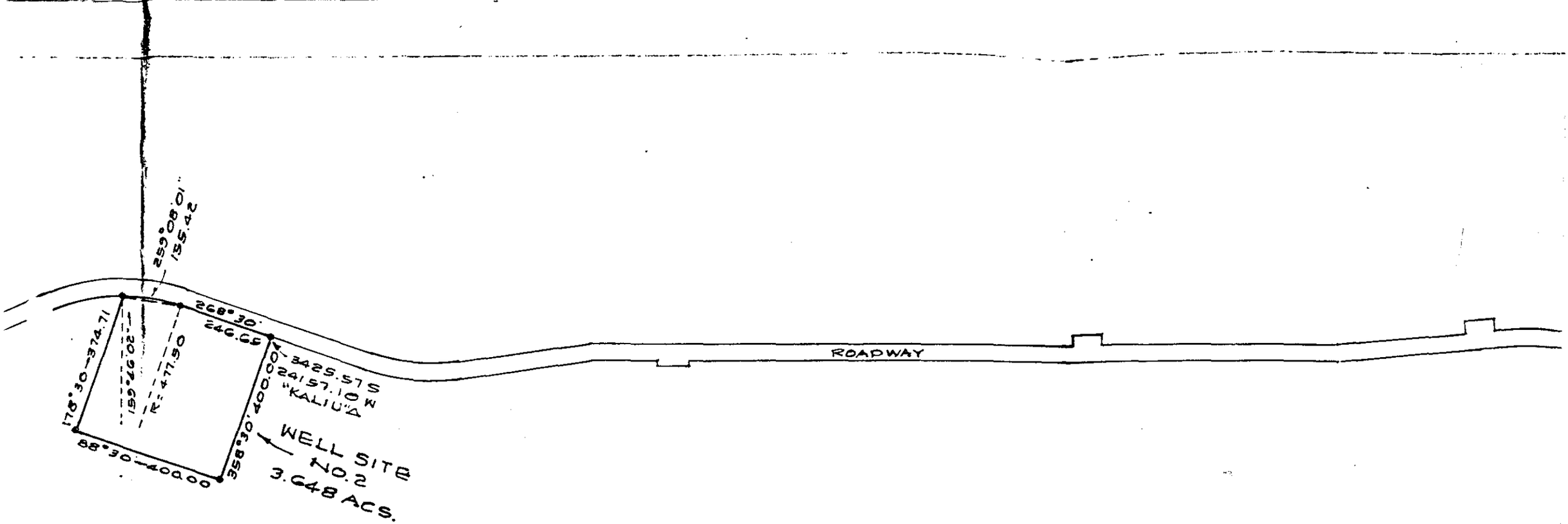
FIGURE 3

PEING R
RATION OF GRANT RIGHT TO
OF JAMES

MAKUU KAOHE, KAIM
PUNA, ISL

SURVEY AND PLAN BY ELLAS SURVEY INC.
P.O.BOX 337, HILO, HAWAII

AUGUST 29, 1990



DRAWING

OF

2

OF PARCEL B

STEEL UNDER THE WELL OF THE ESTATE

WELL DRILLED

NEW KAAPAHU AT HONOLULU

OF HAWAII, HAWAII

YOBUCHIKA SANTO
REGISTERED
PROFESSIONAL
LAND
SURVEYOR
No. 1,343
HAWAII, U.S.A.

Yobuchika Santo

BACKGROUND PREPARATION; FINDINGS

1. Check of historic and archaeological literature. The historic literature (Holmes 1985) shows no recorded trails in the project area. The Wilkes route of 1840 (see map number 3) passes to the south of the project area and the Kaimu Trail, approximately .75km to the south skirts south of Heiheiahulu. The existence of the existing Kaimu Trail lowers the probability of an additional trail passing through the study area but increases the possibility that the area was accessed prehistorically.

Previous archaeological surveys done in the general area include Bonk (1990) Haun and Rosendahl (1985). Bonk did not locate cultural materials, Haun and Rosendahl identified possible prehistoric Hawaiian burial structures and remnant cultigens of ki, and kukui. The structures were located on the southeast summit of Heiheiahulu located to the southeast of the project area.

2. Identification of older bare pahoehoe flows, soil covered pahoehoe and a'a flows, kipuka and cinder cones and the project area. Holmes' (1985) map of lava flows (see map #4) indicates that the project area is at the north extreme of an 1800's flow with a 750 to 1,000 BP flow north of the site. A recent 1961 flow occurred approximately 1 km to the west of the site. There is just one cinder cone in the vicinity which is located well outside the project area to the north.

3. Identification of cultigens. No aerial photographs were made available to us and hence we cannot offer any aerial interpretations of vegetation areas. However, we did not observe any cultivated plants such as banana, ti, or kukui in the research area.

ARCHAEOLOGICAL SURFACE SURVEY: FINDINGS

1. Caves. The pahoehoe portions of the subject property featured numerous inflated dome type caves - in every case, these were found to be very shallow and devoid of any cultural indications. The largest cave observed was no more than 2 meters wide, approximately 3/4 meter high and 2 meters in depth. In comparison, the smallest cave observed was 1/2 meter wide by 1/2 meter high and 1 meter deep. The property also features a number of cracks. The smallest being one foot wide, three feet long and two feet deep. The largest is roughly 100 feet long, twenty feet wide with depths ranging between 25 and 40 feet. There is a cave entrance at the bottom of the largest crack, however, the area is very unstable, with loose, rotting, rock and debris making even a rappelling exercise treacherous to the point of foolishness. There were no cinder cones within the project area.

2. Kipuka Pahoehoe. There were no kipuka observed within the boundaries of the project area.

3. Trails. The Kaimu trail and the Wilkes expedition trail passed east-west approximately 3/4 to 1km to the south of the project area. The proximity of the Hawaiian trail suggests that an additional trail paralleling this one would be unlikely. However, the proximity may have increased the likelihood of prehistoric access to the project area.

4. Reconnaissance Survey: Methodology. A walkthrough reconnaissance survey was completed for the area identified as two proposed well pads (referred to as A and B on figure #4), the proposed well site #2, and an accompanying 200 foot buffer zone. A second walkthrough reconnaissance survey was completed for a buffer zone of 1,000 feet around the proposed well site described above. In other words, the second survey extended the buffer zone an additional 800 feet.

The first survey area was located primarily on the south side of the main entrance road, extending toward the east rift zone. The second survey area for the buffer zone took us into that property which lies south of the entrance road and the north side of the road.

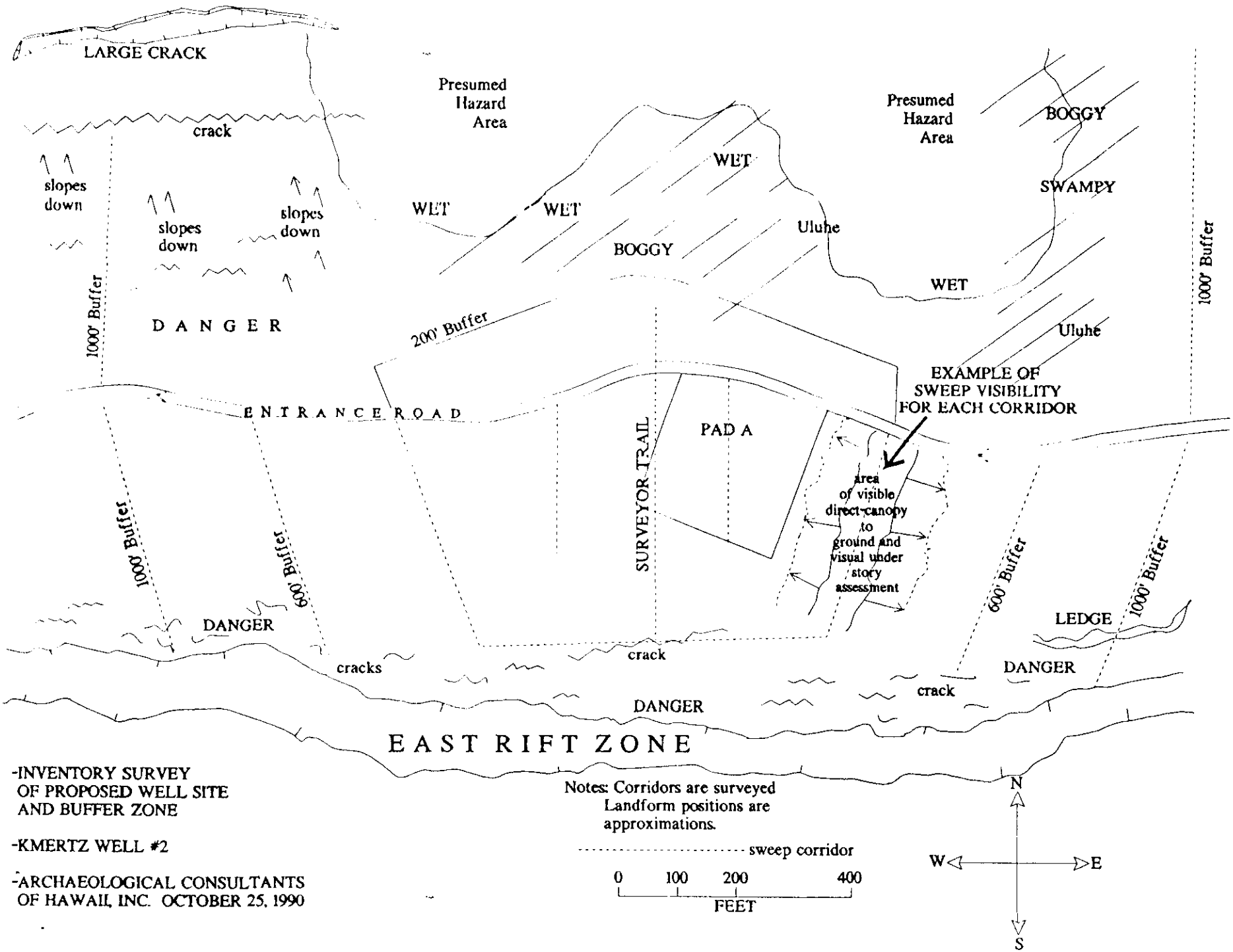
Our initial survey was completed by two individuals who worked for two full days ten hours per day. The second survey was completed by the same two individuals and one assistant for cutting trails and tape measuring. The team worked five hours a day for three days.

The survey team for the initial survey cut a series of four access corridors into the south portion of the property. These extended in a southerly direction toward the east rift zone, at approximate right angles to the main entrance road. Another trail, probably established by Island Survey, provided additional access midway between the corridors established by the ACH team. The team also cut an access corridor at a right angle to the four southerly extending corridors, in the easternmost explorable area. (Please refer to Figure #4).

The survey team for the second survey cut a series of six additional access corridors; two were cut at intervals of 600 feet and 1000 feet on each side of the well pads. These four corridors extended in an easterly direction toward the rift zone. The remaining two corridors were cut into the forest on the north side of the road, 1000 feet out from the corners of the well pads. The team also explored the feasibility of adding another corridor directly opposite the well pads to the north, but surface conditions were deemed too hazardous to continue. (Again, please refer to Figure #4)

These corridors provided a sweep framework for the survey area. We estimate that visual assessment of surface conditions was maintained for a width of no more than twenty feet to each side of each corridor, whose width is estimated to be approximately ten feet, or the average distance between the two team members as they traveled the corridor.

The entire area surveyed is comprised of bog and swamp, dominated by a mixed mesic-type rainforest of 'ohi'a, hapu'u, Kilauea hepyotis, and assorted epiphytic vegetation such as mosses, ferns, and 'ala'alawainui. The majority of 'ohi'a appears to be stunted, probably a result of the boggy conditions. Included to a lesser degree are 'akala, guava, waiawi, 'ie'ie, maile, mamaki, kolea, assorted gingers (mostly 'awapuhi), occasional fleabane, bamboo orchid, iris and lobelia. The roadway bulldozer push (approximately 25 feet on either side) consists mostly of fleabane, mamaki, 'akala, bamboo orchid, iris, guava, a species of melastoma candida, and other exotics.


LARGE CRACK
crack
slopes down
slopes down
slopes down
1000' Buffer
DANGER
Presumed Hazard Area
WET
WET
WET
BOGGY
Uluhe
WET
Presumed Hazard Area
BOGGY
SWAMPY
1000' Buffer
200' Buffer
Uluhe
EXAMPLE OF SWEEP VISIBILITY FOR EACH CORRIDOR
ENTRANCE ROAD
SURVEYOR TRAIL
PAD A
area of visible direct canopy to ground and visual under story assessment
1000' Buffer
600' Buffer
DANGER
cracks
crack
600' Buffer
1000' Buffer
LEDGE
DANGER
crack
DANGER
EAST RIFT ZONE
-INVENTORY SURVEY OF PROPOSED WELL SITE AND BUFFER ZONE
-KMERTZ WELL #2
-ARCHAEOLOGICAL CONSULTANTS OF HAWAII, INC. OCTOBER 25, 1990
Notes: Corridors are surveyed
Landform positions are approximations.
sweep corridor
0 100 200 400
FEET
N
W
E
S

The land mass appears to be mostly pahoehoe, deduced indirectly by the smoothness of the surface and poor drainage conditions of this surface. Small outcrops of a'a were also observed. The pahoehoe is covered with either mud and water, mosses, or a mixture of all three. The mud, soil, and decayed vegetation occurred at a depth of approximately one foot. The mud areas have all been used extensively by pigs, as is evidenced by rooting digging, and chewed hapu'u. In areas in which there are fallen 'ohi'a and/or hapu'u, there are few, if any, caves of any consequence or size. Another observation was the lack of birds. We encountered only a few cardinals, a few finches or sparrows (limited visibility hampered identification). Notably absent is the presence of mongoose.

FINDINGS IN GENERAL

Based on the direct observation of surface conditions along the sweep framework corridors, and on the evaluation of understory and canopy type along the periphery of these corridors, we conclude the following:

Mud, water, and thick accumulations of rotting vegetation prevented any direct contact with bare lava surfaces. The similarity between understory and canopy along the sweep corridor and that which was observed within an approximate 100' periphery leads us to conclude that surface conditions are the same in these outer areas as they are where we could see them directly. Therefore, the percentage of the study area underlain by pahoehoe and a'a, apparent differences in flow age and the distribution of these differences cannot be know at this time.

The large cracks described earlier presented a hazard in all the corridor areas thus far established. However, in both the vicinity of the rift zone and the entire northwestern section of the buffer zone, deep cracks, steep slopes, and obscuring vegetation presented such extreme hazard that additional sweep corridors could not be established. The flatter northeast section of the buffer zone, as was determined from observations off the northeast corridor and the midsection probe, revealed the swampiest conditions encountered over the entire property, and plans for additional corridors were similarly abandoned.

No cultural indicators were located within the buffer area.

FINDINGS FOR WELL SITE AREA #2

No cultural indicators were located within the well site impact area. There were no sightings of any cultigens such as ki, banana, kukui, within the well site area.

DISCUSSION AND RECOMMENDATIONS

The prediction and identification of temporary forest shelter sites used hundreds of years ago by small groups such as bird feather collectors will be extremely difficult. The illusive temporary campsites in this upland forest area can be expected to be either buried, random, or so lacking in diagnostic materials that archaeological identification and data recovery may be impossible or impractical unless camp sites used seasonally over many years are encountered. Hypothetically, two types of campsites may be possible in this area, a short term, one-time-used camp site or campsites which were set up along established travel routes and used year after year.

Presumed campsites have been found in lava tubes in forested areas on Campbell Estate Land. However, because no campsites have been identified, to date, in upland forests, our predictive model continues to be based on a shallow data base.

Archaeological monitoring of soil covered areas after initial grading and grubbing. We feel that a need for some form of monitoring during initial phases of grubbing and grading is important. Monitoring is recommended because of the known presence of lava tubes in the general area.

In addition, Archaeologists will be "on-call" if the 7-1/2 inch drill bit hits an "air void" indicating the possible presence of a cave. At that time, work will stop, the drill bit removed to facilitate the insertion of a fiber optic device to examine the void for cultural materials.

Also, as a special effort to try and identify subsurface remains of trail and forest exploitation, campsites and forest exploitation working areas, this monitoring should occur. It shall only be done in soil areas. The cuts made during grubbing and grading will be inspected to see if these sites can be identified.

The highest likelihood for locating and identifying campsites in the project area will be during the monitoring of vegetation clearing and earth moving. The presence of features such as developed stratigraphic layers, perishable midden accumulations (charcoal and lithic debris) and foundation outlines, should they exist within the project area, will best be tested during this next phase. In this case, standard excavation methods will be applied.

If there are any questions regarding this report, please feel free to contact us.

Aloha,

Joseph Kennedy
Consulting Archaeologist

BIBLIOGRAPHY

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---------- 1988 — An Archaeological Reconnaissance Survey in the Geothermal Resource Subzone of Upper Kaimu and Makena, Puna, Hawaii.

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Kennedy, J. 1982 — An Archaeological Literature Search for the Ahupua'a of Kahauale'a. Ms.

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 South King Street, 6th Floor
Honolulu, Hawaii 96813

October 12, 1990

Mr. Alan Kawada
True Geothermal Energy Company
Central Pacific Plaza, Suite 868
220 South King Street
Honolulu, Hawaii 96813

Dear Mr. Kawada:

SUBJECT: Review of Archaeological Surveys o the Proposed Geothernmal Well Sites for True/Mid-Pacific Geothermal Venture
Former Puna Forest Reserve, Puna, Hawaii
TMK: 1-2-10: 3

The Division of Water Resource Management has forwarded copies of the two archaeological inventory surveys you have submitted to be in compliance with the Decision and Order of CDUA HA-1830 (April 11, 1986). We have reviewed both documents, that of Joseph Kennedy for Geothermal Well Sites # 2 and of William Bonk for Alternative Sites # 2 and # 3, and find that we have a number of concerns about the reports themselves, the degree to which they fulfill the conditions of the CDUA and their adequacy in light of our recent study of lava tubes on Campbell Estate Land. Because our written review will not be completed until Oct. 15, 1990 and you are apparently facing a number of pressing time constraints, this letter focuses on those steps which should be completed before any grading or grubbing can take place at the proposed well sites or along any additional access roads.

For all three proposed well sites we are asking that a survey be made of a rectangular area measuring 1,000 ft. upslope and downslope of the proposed well site (area to be disturbed by construction activity) and 500 ft. northwest and southeast of the well sites. We ask that survey coverage be as close to 100% as possible and that any deviation from this must be justified in the survey report. The alignment of the survey corridor should approximately parallel that of the Kilauea's East Rift Zone. As will be discussed in our forthcoming letter, these distances and alignment will hopefully maximize the probability of locating any lava tube entrances if any exist in the area. We note that the total area asked for in this configuration does not exceed the condition of the CDUA which stipulates that the survey "shall include an area two to five times larger than the actual access road corridors, drill sites, power plants sites ..."

We have some questions about the adequacy of the surveys which took place on the proposed well sites themselves and, if these cannot be answered to our satisfaction, some of the well sites may need to be surveyed again in addition to the extended survey corridor described above.

Once the survey is completed and we have read the written report, we would like to visit the project area before any construction activities take place. This should allow us to better understand the terrain and assess the effectiveness of the survey approaches being applied and any subsequent mitigation planned.

The Decision and Order also mandated the formulation of a research design which would be a guide to conducting archaeological investigations under the CDUA permit. The current research design calls for archaeological monitoring of soil-covered areas after initial grading and grubbing. Because we now know that lava tubes with significant remains could be in the area, we will require that all construction activities entailing grading and grubbing be monitored in case a lava tube is accidentally collapsed or opened. This would eliminate the need for any inspections after the ground disturbing activities have taken place.

The research design also calls for consultations to occur with the State's Historic Sites Section (now the Historic Preservation Division) after each of the three major tasks described in the research design (Background Preparation-Predictions, Archaeological Surface Survey and Archaeological Monitoring). We note that no such consultation occurred before or after the survey of the Geothermal Well Site # 2 and stress that such a consultation is of particular importance because of the problems inherent in identifying lava tubes in the area. Please be sure that the person hired to do the additional surveys contacts our office for this consultation before going into the field.

Although our forthcoming letter will discuss the following in more detail, we would like to make two points concerning the kinds of information we will be expecting in future survey reports:

1. In addition to more specific descriptions of survey methods, a map should be included which shows the area surveyed and, if appropriate, the distribution of the survey sweeps. It would also be helpful if each survey could be depicted on an overall base map which showed all areas that had been surveyed previously.

2. A map should depict, to the extent possible, the distribution of different lava flow surfaces underlying the areas surveyed. If the field crew could be provided with aerial photographs, it would help make this task considerably easier. It could also prove useful in identifing anomolies in the landscape or vegetation which could, in turn, serve as predictive clues to the location of lava tubes or other indicators of past human use in the area.

Division of Wate Resource Management

We hope that this will provide you with enough information to make at least tentative arrangements for the archaelogical work needed in areas that may be effected by your proposed development plans. The final report of our study on lava tubes on Campbell Estate Land will include, in the concluding reccommendations, the guidelines we are developing for all geothermal projects or other developments which take place in areas where lave tubes could be present. We expect this report to be ready for general distribution within the next two weeks.

Sincerely,

DON HIBBARD, Director
Historic Preservation Program

cc. Sus Ono, Office of the Govenor
Manabu Tagomori, Division of Water Resource Management

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 South King Street, 6th Floor
Honolulu, Hawaii 96813

FACSIMILE NUMBER (808) 587-0018

TELECOPIER COVER LETTER

DATE: 10/12/90 HAWAIIAN TIME: _____ AM PM

FROM: Holly McEldowney - Historic Sites Division

TELEPHONE NO.: (___) 587-0008

SEND TO: Dean Nakano

COMPANY: DOWALD

TELECOPIER NO.: (808) 548-6052

TELEPHONE NO.: (___) _____

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IF ALL PAGES ARE NOT RECEIVED, PLEASE CALL SENDER'S NUMBER AS SOON AS POSSIBLE. ASK FOR Holly.

SPECIAL INSTRUCTIONS:

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 South King Street, 6th Floor
Honolulu, Hawaii 96813

October 12, 1990

Mr. Alan Kawada
True Geothermal Energy Company
Central Pacific Plaza, Suite 888
220 South King Street
Honolulu, Hawaii 96813

Dear Mr. Kawada:

SUBJECT: Review of Archaeological Surveys o the Proposed Geothernmal Well Sites for True/Mid-Pacific Geothermal Venture
Former Puna Forest Reserve, Puna, Hawaii
TMK: 1-2-10: 3

The Division of Water Resource Management has forwarded copies of the two archaeological inventory surveys you have submitted to be in compliance with the Decision and Order of CDUA HA-1830 (April 11, 1988). We have reviewed both documents, that of Joseph Kennady for Geothermal Well Sites # 2 and of William Bonk for Alternative Sites # 2 and # 3, and find that we have a number of concerns about the reports themselves, the degree to which they fulfill the conditions of the CDUA and their adequacy in light of our recent study of lava tubes on Campbell Estate Land. Because our written review will not be completed until Oct. 15, 1990 and you are apparently facing a number of pressing time constraints, this letter focuses on those steps which should be completed before any grading or grubbing can take place at the proposed well sites or along any additional access roads.

For all three proposed well sites we are asking that a survey be made of a rectangular area measuring 1,000 ft. upslope and downslope of the proposed well site (area to be disturbed by construction activity) and 500 ft. northwest and southeast of the well sites. We ask that survey coverage be as close to 100% as possible and that any deviation from this must be justified in the survey report. The alignment of the survey corridor should approximately parallel that of the Kilauea's East Rift Zone. As will be discussed in our forthcoming letter, these distances and alignment will hopefully maximize the probability of locating any lava tube entrances if any exist in the area. We note that the total area asked for in this configuration does not exceed the condition of the CDUA which stipulates that the survey "shall include an area two to five times larger than the actual access road corridors, drill sites, power plants sites ..."

We have some questions about the adequacy of the surveys which took place on the proposed well sites themselves and, if these cannot be answered to our satisfaction, some of the well sites may need to be surveyed again in addition to the extended survey corridor described above.

Once the survey is completed and we have read the written report, we would like to visit the project area before any construction activities take place. This should allow us to better understand the terrain and assess the effectiveness of the survey approaches being applied and any subsequent mitigation planned.

The Decision and Order also mandated the formulation of a research design which would be a guide to conducting archaeological investigations under the CDUA permit. The current research design calls for archaeological monitoring of soil-covered areas after initial grading and grubbing. Because we now know that lava tubes with significant remains could be in the area, we will require that all construction activities entailing grading and grubbing be monitored in case a lava tube is accidentally collapsed or opened. This would eliminate the need for any inspections after the ground disturbing activities have taken place.

The research design also calls for consultations to occur with the State's Historic Sites Section (now the Historic Preservation Division) after each of the three major tasks described in the research design (Background Preparation-Predictions, Archaeological Surface Survey and Archaeological Monitoring). We note that no such consultation occurred before or after the survey of the Geothermal Well Site # 2 and stress that such a consultation is of particular importance because of the problems inherent in identifying lava tubes in the area. Please be sure that the person hired to do the additional surveys contacts our office for this consultation before going into the field.

Although our forthcoming letter will discuss the following in more detail, we would like to make two points concerning the kinds of information we will be expecting in future survey reports:

1. In addition to more specific descriptions of survey methods, a map should be included which shows the area surveyed and, if appropriate, the distribution of the survey sweeps. It would also be helpful if each survey could be depicted on an overall base map which showed all areas that had been surveyed previously.

2. A map should depict, to the extent possible, the distribution of different lava flow surfaces underlying the areas surveyed. If the field crew could be provided with aerial photographs, it would help make this task considerably easier. It could also prove useful in identifing anomolies in the landscape or vegetation which could, in turn, serve as predictive clues to the location of lava tubes or other indicators of past human use in the area.

We hope that this will provide you with enough information to make at least tentative arrangements for the archaelogical work needed in areas that may be effected by your proposed development plans. The final report of our study on lava tubes on Campbell Estate Land will include, in the concluding reccommendations, the guidelines we are developing for all geothermal projects or other developments which take place in areas where lave tubes could be present. We expect this report to be ready for general distribution within the next two weeks.

Sincerely,

DON HIBBARD, Director
Historic Preservation Program

cc. Sus Ono, Office of the Govenor
Manabu Tagomori, Division of Water Resource Management

State of Hawaii
Department of Land and Natural Resources
Division of Water Resource Management
Honolulu, Hawaii

OCT 11 1990

MEMORANDUM

TO: Mr. Michael Buck, Administrator
Division of Forestry and Wildlife

FROM: Manabu Tagomori, Deputy Director

SUBJECT: Response to DOFAW Comments on the Ornithological and Botanical Surveys Submitted by True/MidPacific Geothermal

Transmitted for your review and files is an October 4, 1990 letter from True Geothermal Energy Company responding to your Division's comments on the Company's ornithological and botanical surveys.

The Division of Water Resource Management has no objections to the Company's proposed semi-annual bird surveys or quarterly botanical monitoring for areas proposed for development. We would appreciate your reviewing the plans, when they are submitted.

Please provide us a file copy of any correspondence concerning the above. Should you have any questions, please contact me directly at Ext. 87533.

Thank you for your continued assistance.

DN:mh

Attach.

TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA

Telephone No.: 808-528-3496
FAX No.: 808-526-1772
220 South King Street
Suite 868
Honolulu, HI 96813

October 4, 1990

Mr. Manabu Tagomori
Deputy Director
Department of Land and Natural Resources
State of Hawaii
Kalanimoku Building, Room 227
1151 Punchbowl Street
Honolulu, Hawaii 96813

Subject: Response to Letter Dated September 28, 1990 from Michael G. Buck

Dear Mr. Tagomori,

We have received and reviewed the above referenced letter and circulated it among the appropriate scientists concerned. After their respective reviews, I have spoken with Dr. Charles Lamoureux (botanical consultant) and Mr. Jack Jefferies (ornithological consultant) to receive their comments and recommendations.

In regard to the ornithological comments in the department's letter, Mr. Jack Jefferies has recommended that follow-up field investigations be conducted every six (6) months. In that manner, a survey of birds may be done to account for any possible differences in bird inventories and populations due to seasonal variations and influences. At the same time, follow-up monitoring of the Hawaiian Hawk's nest in the vicinity of proposed drill site number 2 may be done to determine if the nest is used again.

Mr. Jefferie's recommendations are based upon his experience with the federal program at the Hakalau Forest National Wildlife Refuge Bird Survey and the state program to monitor and count the Hawaiian Palila during its breeding and non-breeding seasons. The surveys to inventory the birds at the various well sites will be done at various sampling areas at sites proposed for use.

Secondly, in regard to the botanical comments, Dr. Lamoureux has discussed them personally with Dr. Carolyn Corn of your department. The reason for the lack of the identification of the plant cyrtandra to the species level, was due to the impossibility of identification without the plant being in a flowering state. Dr. Lamoureux will conduct periodic quarterly monitoring of the areas proposed for development and he can at that time seek to further identify the species of cyrtandra.

Thirdly, a map is being prepared by Mr. Nobu Santo of Island Survey, Inc. which will show on one map, all of the drill or well sites that have been surveyed and considered for development. The map should be completed within one week and will be fowarded to you under separate cover.

The discovery of the plants Tetraplasandra Hawaiiensis and Bobea Timonioides, have been recorded and mapped in an earlier report submitted to your department as part of the regulatory procedure for approval of drill or well site number 1. The overall map referred to earlier, will show the drill or well sites in relation to each other and thus placement of the plants will be made easier.

Lastly, a weed monitoring and biological management plan has been submitted to your department for review and acceptance. As soon as acceptance has been verified, implementing measures will be undertaken to respond to your concerns in the last paragraph of your department's letter.

Thank you for your assistance and recommendations concerning our reports. Should you have any questions please do not hesitate to call us at 528-3496.

Very truly yours,

TRUE GEOTHERMAL ENERGY COMPANY

Allan G. Kawada

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE HISTORIC PRESERVATION
STATE PARKS
WATER RESOURCES MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

September 28, 1990

True/Mid-Pacific Geothermal
Central Pacific Plaza
220 South King Street
Honolulu, Hawaii 96813

Dear Sirs:

This provides comments on the Ornithological and Botanical Surveys for True/Mid-Pacific Geothermal Venture's Well Site #2 and Alternate Well Sites #2 and 3, located in Puna on the Island of Hawaii. The Division of Water Resource Management of our Department has asked us to respond directly to you.

The ornithological reports provide thorough and complete documentation of the surveys made and are acceptable as far as they go. However, as only 6 days were spent in August-September at well site number 2 and one day at alternate sites limited to narrow time frames and seasons of the year. It is possible that other species may be present during other periods, or revealed with more frequent surveys. Monitoring should encompass at least the mid-summer and mid-winter periods (preferably, quarterly) at each site. The major impact of the development of these sites may be on the Hawaiian hawk. Inventories of nest tree sites before development to prevent their destruction, and monitoring of known nesting tree sites before, during and after development should be an integral part of the project. The scope of these surveys should include the sites proper and an appropriate zone around each. The monitoring should include a determination of the effects of noise and disturbance on the annual cycle of the hawk.

Comments on the "Botanical Survey for the Proposed Well Site #2" by Dr. Charles Lamoureux (August, 1990) were addressed in an earlier memorandum dated September 21, 1990.

Comments follow for the "Botanical Survey of Proposed Alternate Well Sites 2 and 3 and the Proposed Roads Leading to these sites from Well site 1" by Charles H. Lamoureux, W. Arthur Whistler and Clyde T. Imada (January, 1990). The survey was made by botanists' familiar with the Hawaiian flora and includes the plant species seen on the survey. However, an adequate map is needed to clarify which areas were surveyed, (the proposed roads

and proposed alternate well sites 2 and 3), existing roads, locations where rare plants (Tetraplasandra hawaiiensis and Bobea timonioides) are known to exist, and the Proposed Well Site #2 surveyed in August 1990. This botanical survey records 57% native species compared to 71% native species for Proposed Well Site #2 (August, 1990). Also a seemingly conflicting statement on rare plants (Bobea timonioides and Tetraplasandra hawaiiensis) not being found in these surveys, but encountered along the road leading from the edge of the property to Well Site 1 hopefully can be clarified through a map. Introduced weeds can be expected to increase as a consequence of opening up the forest as construction occurs. Incorporation of the botanical survey recommendations, weed monitoring and control should be practiced by the applicant.

If you have any questions, please contact Ron Walker (ornithology) or Carolyn Corn (botany) at 548-8850.

Sincerely yours,

MICHAEL G. BUCK
Administrator

cc: Division of Water Resource Management

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIV. OF WATER & LAND DEVELOPMENT
DIVISION OF FORESTRY AND WILDLIFE
1151 PUNCHBOWL STREET
HONOLULU, HAWAII 96813

September 28, 1990

True/Mid-Pacific Geothermal
Central Pacific Plaza
220 South King Street
Honolulu, Hawaii 96813

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If you have any questions, please contact Ron Walker (ornithology) or Carolyn Corn (botany) at 548-8850.

Sincerely yours,

MICHAEL G. BUCK
Administrator

cc: Division of Water Resource Management

September 21, 1990

MEMORANDUM

TO: Manabu Tagamori, Deputy Director
Commission of Water Resources

FROM: Michael G. Buck, Administrator

SUBJECT: Botanical Survey of the Proposed Well Site for True/Mid-Pacific Geothermal Venture Located at Puna, Hawaii

In response to your memorandum on the above subject dated September 5, 1990, the Botanical Survey for the Proposed Well Site #2 (400 x 400 foot area) was reviewed.

This well site was surveyed by a competent botanist. It reportedly has a 71% native plant composition with 40 of 73 plant taxa (55%) endemic to the Hawaiian Islands. No endangered or candidate plants proposed for listing as endangered were found in the survey area. However, one cyrtandra was not identified to species. This cyrtandra, if possible, should be identified to the species level. (It could be a rare cyrtandra, C. giffardii, known from the wet forest near Kilauea, which is a Category 1 U.S. Fish & Wildlife Service plant taxon under review for listing as a threatened or endangered species.) No information is given in this report to indicate the abundance of this Cyrtandra sp. or any other species.

No mention is made in this report why the well site is within the forest rather than on the nearby 1961 lava flow, which biologically would support fewer species and create less biological impact.

Identification of the Cyrtandra sp. and abundance ratings for each listed plant taxon should clarify ambiguities. The location of the well site within an area with fewer native species should also be considered.

The report offers good recommendations that should reduce the size of the impact of the well site upon the surrounding flora and fauna.

DEPARTMENT OF LAND AND NATURAL RESOURCES

DIVISION OF FORESTRY AND WILDLIFE

September 21, 1990

MEMORANDUM

TO: Manabu Tagamori, Deputy Director
Commission of Water Resources

FROM: Michael G. Buck, Administrator

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The report offers good recommendations that should reduce the size of the impact of the well site upon the surrounding flora and fauna.

State of Hawaii
Department of Land and Natural Resources
Division of Water Resource Management
Honolulu, Hawaii

SEP 19 1990

MEMORANDUM

TO: Michael Buck, Administrator
Division of Forestry and Wildlife

FROM: Manabu Tagomori, Deputy Director

SUBJECT: Hawaiian Hawk Nesting Activities at True/Mid-Pacific Geothermal Venture's Proposed Well Site # 2, Hawaii

Transmitted for your review and approval is a follow-up report on the Hawaiian Hawk's nesting activities at the proposed Well Site # 2 for True/Mid-Pacific Geothermal Venture (Applicant). This report should be reviewed in conjunction with Applicant's other ornithological survey transmitted on 9/18/90.

We ask that you review this supplemental report and reply directly to the Applicant. Please provide the Division of Water Resource Management a copy for our files. Should you have any questions, please contact me directly at Ext. 87533.

DN:mh

Encl.

State of Hawaii
Department of Land and Natural Resources
Division of Water Resource Management
Honolulu, Hawaii

SEP 18 1990

MEMORANDUM

TO: Don Hibbard, Director
Historic Preservation Program

FROM: Manabu Tagomori, Deputy Director

SUBJECT: Archaelogical Surveys of the Proposed Geothermal Well Sites for True/Mid-Pacific Geothermal Venture

Transmitted herewith for your review and approval are the Archaeological Surveys submitted by True/Mid-Pacific Geothermal Venture (Applicant) for its proposed Geothermal Well Sites # 2, and Alternate Well Sites # 2 and # 3. Maps within the separate reports identify the locations of the proposed drill sites in relation to the current site of True/Mid-Pacific geothermal well A1-1.

These surveys were prepared in compliance with the Board's Decision and Order (D/O) of April 11, 1986, and submitted to the Department for approval. As such, we respectfully request your review of the enclosed documents and a direct reply to the Applicant of your approval and/or comments.

Please provide the Division of Water Resource Management a file copy of any correspondence concerning the above surveys. Should you have any questions, please contact me directly at Ext. 87533.

Thank you for your continued assistance.

DN:mh

Encl.

State of Hawaii
Department of Land and Natural Resources
Division of Water Resource Management
Honolulu, Hawaii

SEP 18 1990

MEMORANDUM

TO: Michael Buck, Administrator
Division of Forestry and Wildlife

FROM: Manabu Tagomori, Deputy Director

SUBJECT: Ornithological and Botanical Surveys for True/Mid-Pacific Geothermal Venture's Well Site # 2 and ~~Alternate Well Sites # 2~~ and Alternate Well Sites # 2 and # 3 Located at Puna, Hawaii

Transmitted for your review and approval is the ornithological survey of the proposed Well Site # 2 for True/Mid-Pacific Geothermal Venture (Applicant). This report is required by the Board's Decision and Order (D/O) of April 11, 1986, and should be reviewed in conjunction with the Applicant's botanical survey transmitted to your division on 9/5/90. (For your information, Applicant has indicated that a supplemental ornithological report for Well Site # 2 will be submitted shortly.)

In addition, Applicant has submitted separate ornithological and botanical surveys for Alternate Well Sites # 2 and # 3 for your review and approval. The study area of the alternate well sites are identified on the enclosed maps.

Pursuant to the Board's D/O, these surveys must be submitted to the Department for approval prior to commencement of any clearing activities. As such, we respectfully request your review of the submitted documents and a direct reply to the Applicant of your approval and/or comments.

Please provide the Division of Water Resource Management a file copy of any correspondence concerning the above surveys. Should you have any questions, please contact me directly at Ext. 87533.

Thank you for your continued assistance.

DN:mh

Encl.

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
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AQUACULTURE DEVELOPMENT PROGRAM
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LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

SEP 13 1990

Mr. Allan G. Kawada
True Geothermal Energy Company
Central Pacific Plaza
220 South King Street, Suite 868
Honolulu, Hawaii 96813

Dear Mr. Kawada:

This is to acknowledge the receipt of the Botanical, Ornithological and Archaeological Surveys, and Metes and Bounds Descriptions for True/Mid-Pacific Geothermal Venture's proposed Well Site # 2 and Alternate Well Sites # 2 and # 3.

The submitted documents will be reviewed by our Department and notification provided upon completion of our evaluation. Please be advised that no clearing activities shall commence prior to approval of the above surveys. Should you have any questions, please contact me at 548-7533.

Sincerely,

MANABU TAGOMORI
Deputy Director

DN:mh

TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA

Telephone No.: 808-528-3496
FAX No.: 808-526-1775
220 South King Street
Suite 868
Honolulu, HI 96813

September 13, 1990

Mr. Manabu Tagomori
Deputy Director
Department of Land and Natural Resources
State of Hawaii
Kalanimoku Building, Room 227
1151 Punchbowl Street
Honolulu, Hawaii 96813

Subject: Status Report of Hawaiian Hawk Nesting Activities at Proposed Drill Site Number Two (2)

Dear Mr. Tagomori,

Enclosed is a copy of the above described report for your review and approval. In the earlier ornithological report dated August 16, 1990 sent to you, the sighting of a hawaiian hawk's nest was discussed.

Subsequent to the sighting of the nest, follow up investigations concerning the status of the nest and fledgling hawk were conducted. The enclosed report discusses the findings of those investigations and a recommendation as to follow-up activities.

If in the future, Mr. Jack Jeffrey finds it advisable that further investigations be conducted, True Geothermal Energy Company will have those investigations completed and those reports submitted to you. In the meantime, this will serve as a final report to you on the hawk's nest.

Should you have any questions please feel free to call our office at 528-3496.

Very truly yours,

TRUE GEOTHERMAL ENERGY COMPANY

Allan G. Kawada

AGK/gcp

A STATUS REPORT

OF

HAWAIIAN HAWK NESTING ACTIVITIES

AT THE

PROPOSED WELL SITE #2

DLNR DESIGNATED GEOTHERMAL RESOURCE SUBZONE
KILAUEA MIDDLE EAST RIFT ZONE
PUNA DISTRICT
ISLAND OF HAWAII

SEPTEMBER 8, 1990

BY

JACK JEFFREY

PREPARED FOR:

TRUE/MID PACIFIC GEOTHERMAL VENTURE

INTRODUCTION

On August 11, 1990 during an ornithological survey at the True/Mid Pacific Geothermal Venture proposed well site #2, a Hawaiian hawk (*Buteo solitarius*) nest with a nestling was found approximately 430 feet from the proposed well pad clearing. The U.S. Fish and Wildlife Service and the State of Hawaii have listed the Hawaiian hawk as an endangered species. Future development in this area could be impacted by the presence of this endangered avian species and its nest in such close proximity to the proposed well site. This report summarizes the results of observations at the nest on August 12, 19 and 25 and September 2, 1990.

METHODS

Observations of 1 - 3 hours each were made using 8 x 30 Zeiss binoculars from a natural blind approximately 90 feet from the active Hawaiian hawk's nest. Thick staghorn fern and other vegetation kept the observer hidden from view of the nesting hawks. Presence or absence of the nestling in the nest, interactions between adults and the nestling and behaviors of the young bird were noted.

FINDINGS

The nest was found on August 11, 1990 during an initial avian survey of the proposed well site area. The nestling was first heard, then seen calling from a perch approximately 50 feet from the nest.

During the second day of the survey, August 12, the nestling was seen on the nest at which time an adult was observed bringing food to the nestling. During 3 subsequent observation days, totalling nine hours at the nest, no parents were seen. The juvenile hawk was never seen again on the nest after August 12 but was continually observed perched within 50 -100 feet of the nest. A favored perch was 75 feet north of the nest, 35 feet above the ground, on a dead branch in a large ohia tree. The fledgling spent over 50% of the observed time at this perch and divided the remainder of its observed time almost equally among three other perches at 50 - 100 feet from the nest. The fledgling called intermittently with bouts of calling sometimes lasting 8 - 10 minutes and calls 5 - 10 seconds apart. These calls

presumably were made to attract the attention of the adults for feeding.

Numerous helicopter flights over the nest site were noted (1-3 per hour) and generators at the drilling rig 3500 feet away could be heard continuously. The nestling showed no apparent behavioral abnormalities or short-term effects resulting from these low level sounds.

On September 2, 1990 no hawks were seen or heard in the nest area during three hours of observation. The fledgling had most likely left the nest area prior to this date.

DISCUSSION

Although no Hawaiian hawks nests have been previously found in the middle east rift zone, the presence of this nest is not unique as other Hawaiian hawk nests have been found nearby in other parts of the Puna District (Griffin 1985, Jeffrey 1986, Scott et al 1986).

Hawaiian Hawks will nest in a variety of habitats although habitat preferences have not been substantiated. Griffin (1985) noted Hawaiian hawks nesting in marginal forests in or near agricultural areas, in exotic forests as well as in native forests. A preference for large trees to support their relatively large nests was also noted. Numerous large ohia trees for use as possible nest sites plus high density of prey species (small birds) make many of the Puna native forest areas very suitable Hawaiian hawk habitat.

Hawaiian hawks begin breeding in March/April with most eggs hatching in June. Nestlings fledge 8-9 weeks after hatching with most fledging in August but remaining in the natal territory up to a year (Griffin 1985). The age and timing of fledging of the nestling at well site #2 was consistent with this behavior as it had fledged and left the nest area by the end of August.

Human disturbance and habitat destruction are two suspected major causes of historic Hawaiian hawk population decline. These birds are most vulnerable during the nesting period. Human activities very close to the nest and other human disturbances may cause abandonment of eggs or nestlings by the parents (Hawaiian Hawk Recovery Plan, Griffin 1985, Scott et al. 1986).

Noise levels at the nest site were intermittently high. Tour helicopters visiting the most recent Kilauea eruption consistently flew at low altitudes over or near the nest

site. Fly-over rates varied from 1-3 per hour during observation periods. These helicopters most likely have been flying over the nest site prior to and during the occupation of the present nest. Also, drilling operations were underway on August 11, and during other observations. The sounds of generating equipment at the drill rig 3500 feet away were consistantly audible although muffled by distance and forest.

No abnormal behaviors were noted at this nest and it is suspected that the birds had become habituated to these noise conditions. Observations made at two other Hawaiian hawk nests in the Puna area when helicopter activity was present showed short-term agitation and apparent nervousness when over flights were close by. At one nest adjacent to a papaya field (300 feet), bulldozing operations and field workers worked continuously throughout the nesting period causing only minor agitation in the adults and young. Both nests were successful (pers. obs.).

Workers at the drill rig at well site #1 report having seen hawks on many occasions perched in trees at the edge of the well site clearing as well as flying near the rigs during day time drilling operations.

COMMENTS AND RECOMMENDATIONS

Some data indicate that Hawaiian hawks subjected to intermittent low levels of noise and minor disturbances may become sufficiently habituated to these disturbances to be able to produce a successful nest (pers. obs.) Although the effect of long-term high levels of noise and disturbance are not well known, they are suspected of having detrimental impact (i.e. through egg or nestling abandonment.) Griffin 1985 and The Hawaiian Hawk Recovery Plan 1984.)

Hawaiian hawks are known to re-use nests during subsequent nestings but may not nest every year due to the prolonged post-fledgling period (Griffin 1985).

It is recommended that the nest at the proposed well site #2 be monitored during the March/April 1991 breeding period to determine if renesting is occurring. If the nest is reactivated, then noise levels and disturbance should be kept to a minimum at the well site adjacent to the nest until the nestling(s) have fledged. Observations should be made intermittently to determine the nest/nestling status.

Although successful nests have been found in small forested kipukas in agriculturally cleared areas, clearing around active nests is known to cause abandonment (Griffin

1985). It is recommended that a non-cleared forest buffer of at least 400 feet, and more if possible, be maintained around any Hawaiian hawk nests found. This distance should not be construed as on optimal buffer zone. Data are limited and more information is needed before the optimal buffer zone distance can de determined. If the nest is active, clearing or disturbance within 1000 feet should be curtailed or minimized until the nestlings have fledged.

All subsequent proposed well sites should be checked thoroughly for Hawaiian hawk nests. Due to terrain and thick vegetation of the area, it may be close to impossible to find all nests. Surveys made during late July through early August will increase the chances of finding active nests because of the intermittent loud calling of the nestling, keying the observer to the nest position.

Careful planning and cooperation between developers and biologists and appropriate detailed monitoring within the development area will generate data useful for future planning.

LITERATURE CITED

DLNR 1986. Indigenous wildlife, endangered and threatened wildlife and plants, and introduced wild birds. Department of Land and Natural Resources. State of Hawaii, Administrative Rule 28 August 1986.

Griffin, C.R. 1985 Biology of the Hawaiian Hawk Buteo solatarius. Ph. D. Dissertation. University of Missouri, Columbia.

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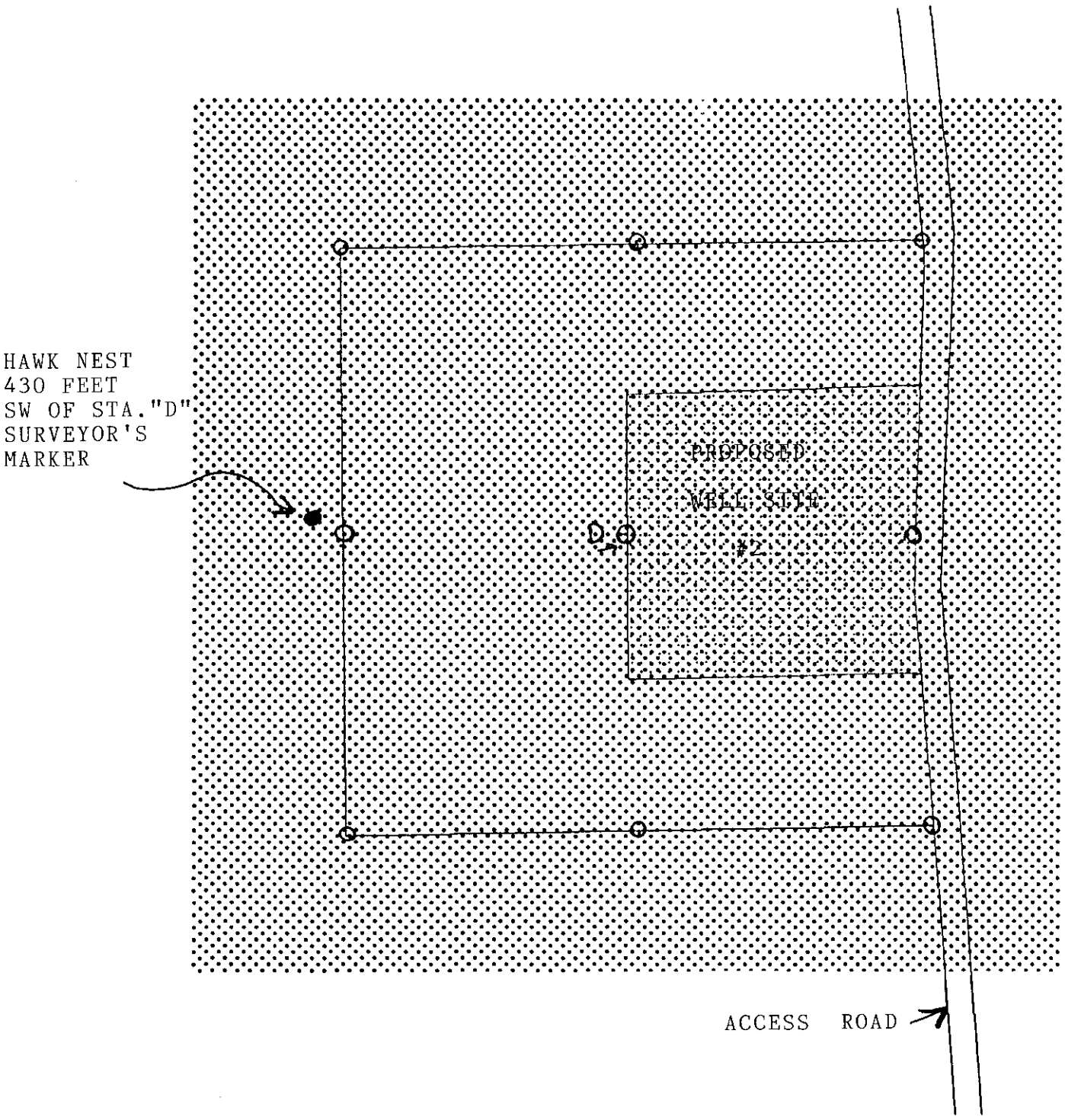
MEASURED LOCATION OF
HAWAIIAN HAWK NEST
AT WELL SITE #2



TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA
220 South King Street
Suite 806
Honolulu, HI 96813
Telephone No.: 808-528-3496
FAX No.: 808-521-1772

90 SEP 7 P4:42

September 7, 1990

DIV. OF WATER & LAND DEVELOPMENT

Mr. Manabu Tagomori
Deputy Director
Department of Land and Natural Resources
Kalanimoku Building, Room 227
1151 Punchbowl Street
Honolulu, Hawaii 96813

Subject: Reports on the Archaeological Reconnaissance Survey and Ornithological Assessment of Drill Site 2 in the Kilauea Middle East Rift Zone (KMERZ)

Dear Mr. Tagomori,

Enclosed are copies of the above referenced reports for your review and acceptance. The reports and surveys are being submitted in compliance with the requirement in the Decision and Order of the Board of Land and Natural Resources dated April 11, 1986.

On August 30, 1990, the report on the botanical survey was submitted to your department for review and acceptance.

No clearing or grubbing will be done until the necessary permits have been granted by the County of Hawaii and until the reports submitted to your department have been approved and accepted.

Other archaeological, botanical and ornithological reports have been submitted to your department concerning alternate drill sites number 2 & 3. These reports are separate and apart from the reports being submitted under this letter since they concern a different location.

Should you have any questions please call our office at 528-3496.

Very Truly Yours,

TRUE GEOTHERMAL ENERGY COMPANY

Allan G. Kawada

AGK/gcp

ARCHAEOLOGICAL CONSULTANTS
of
HAWAII

59-624 Pupukea Rd.
Haleiwa, Hawaii 96712
(808) 638-7442

JOSEPH KENNEDY
Archaeologist

Mr. Alan Kawada
True Mid Pacific Geothermal
Central Pacific Plaza Suite 868
220 South King
Honolulu, Hawaii 96813

September 6, 1990

Dear Mr. Kawada:

INTRODUCTION AND PHYSICAL SETTING

At the request of your office, Archaeological Consultants of Hawaii, Inc. has conducted an inventory survey at the site of the proposed Kilauea Middle East Rift Zone (KMERZ), Well Site #2, TMK: 1-2-10:3. This proposed well site is located in the Wao Kele O Puna Natural Area Reserve, Island of Hawaii (see maps #1 and 2).

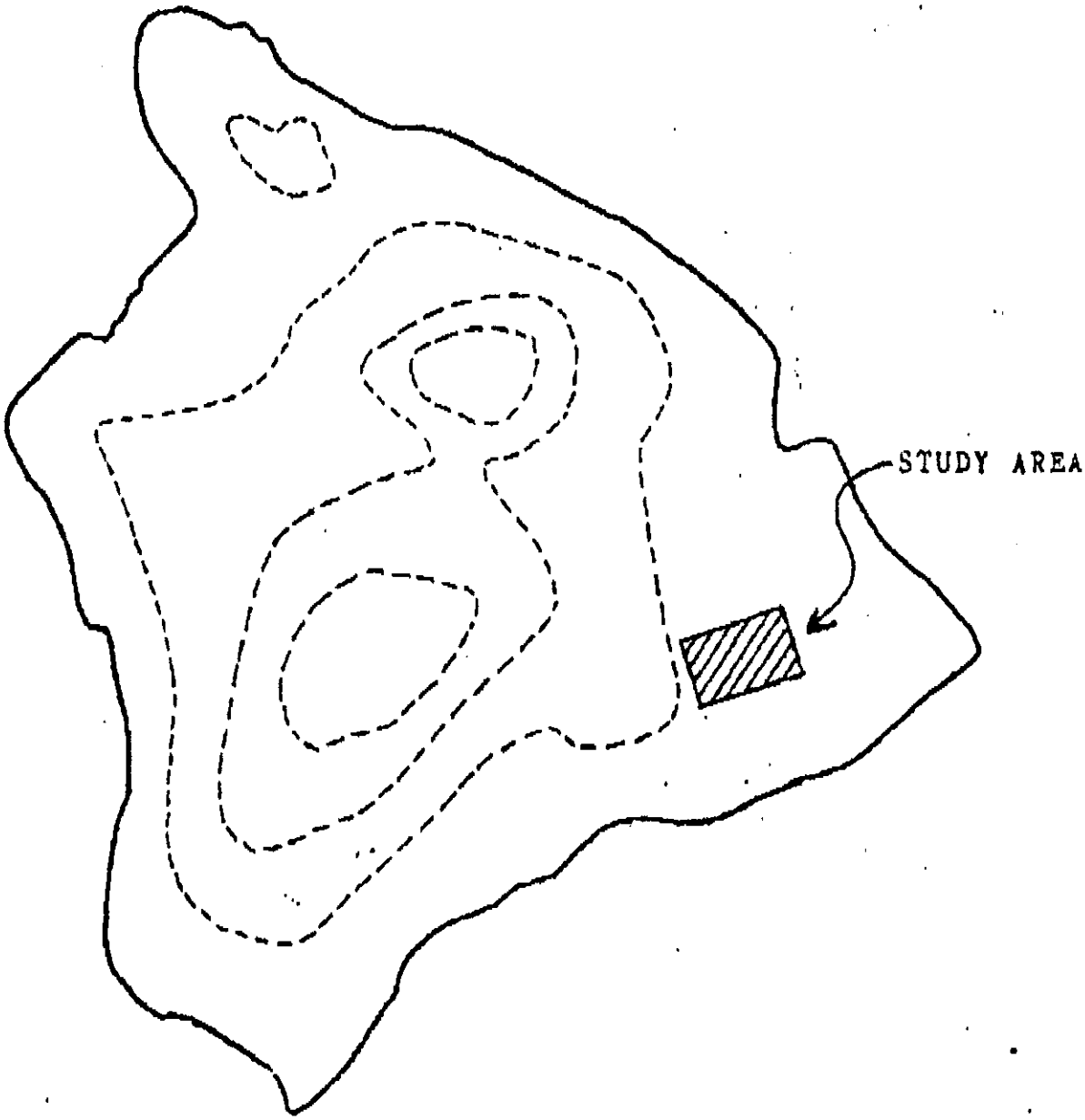
The subject property features an extremely rugged topography and an unusually thick vegetatative profile which combine to present some of the most difficult survey areas in the state. A thick mat of stony muck rests on mostly recent a'a and is covered with very dense uluhe, 'ie'ie, hapu'u, guava, ohi'a and a number of additional plants, vines and grasses. The reader may wish to refer to the numerous and recently completed botanical studies of this area for a more complete listing.

PURPOSE OF WORK

A variety of archaeological sites may be expected in the vast forest lands where True/Mid-Pacific Geothermal Venture will be conducting its geothermal exploration activities. Although the sites' distribution generally will be sparse and although most project activities may well miss the sites, it important to have adequate plans to identify historic sites, so the sites can be avoided or appropriately mitigated Special identification problems exist in forest lands, and for this reason an archaeological research design for archaeological survey methods was required under CDUA HA-1830 as part of an archaeological plan.

Archaeological Consultants of Hawaii, Inc.
59-624 Pupukea Rd.
Haleiwa, Hawaii 96712

MAP 1



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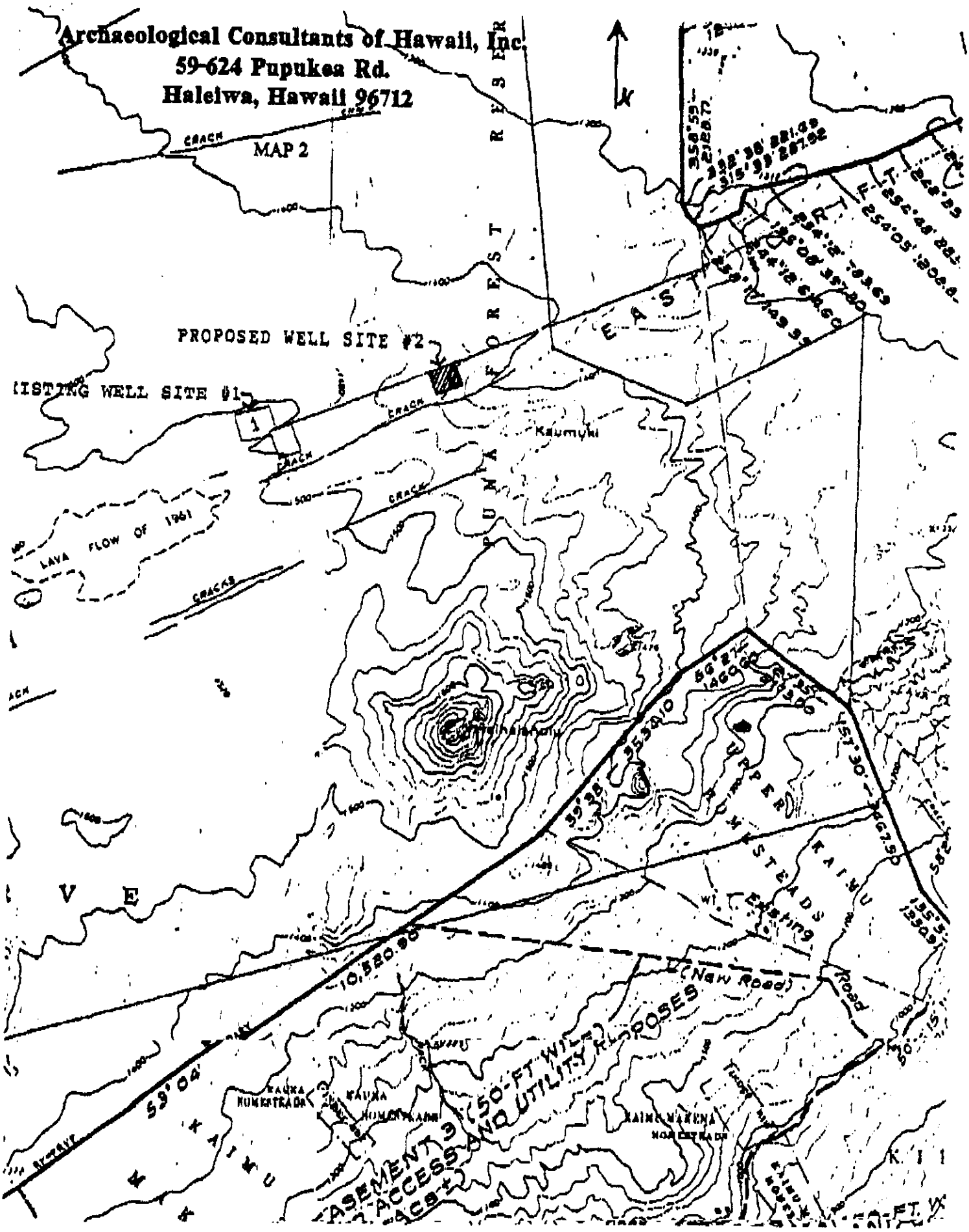

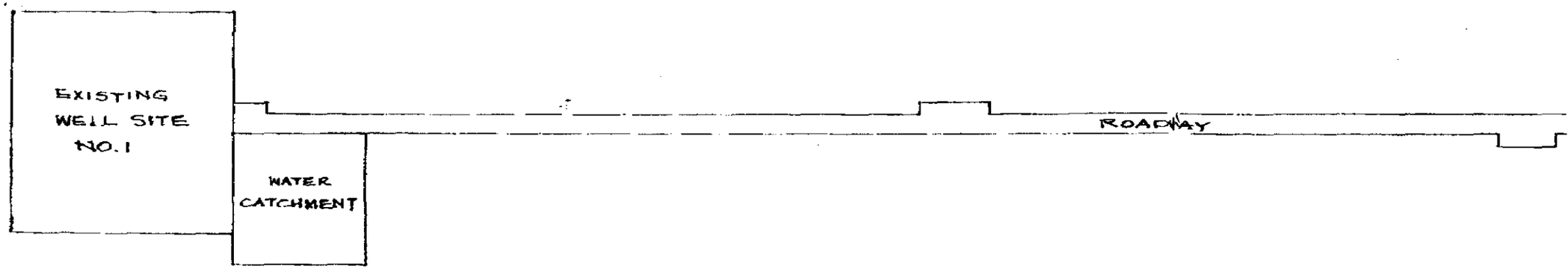

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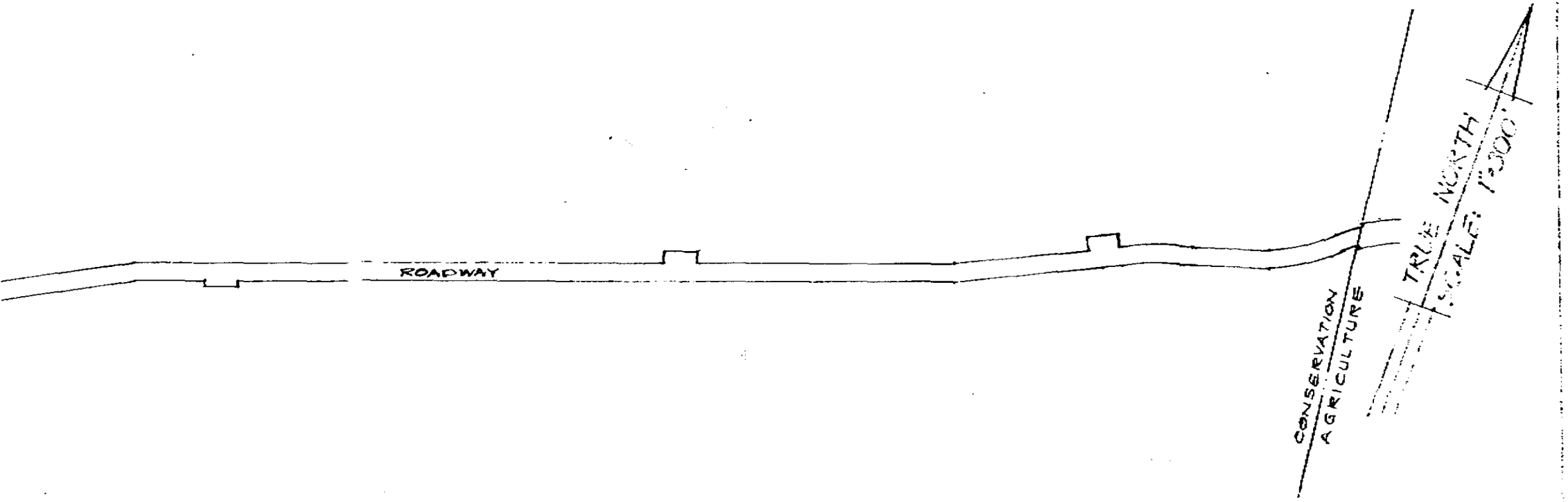
SURVEY AND PLAN BY ISLAND SURVEY, INC.
P.O.BOX 337, HILO, HAWAII

AUGUST 29, 1990



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L.

YOBUCHIKA SANTO
REGISTERED PROFESSIONAL LAND SURVEYOR
No. 1360
HAWAII, U.S.A.

Yobuchika Santo

PREHISTORIC AND EARLY HISTORIC LAND USE IN THE PROJECT AREA AND ANTICIPATED HISTORIC SITES

Historic and archaeological research in this area as well in other similar environmental zones on Hawaii Island, indicate that prehistorically such areas were used for:

1. Forest product exploitation. Bird feathers, timber, vines, etc. were collected in the forests at or near worksites, and campsites were nearby. These sites should be scattered around much of the project area, in low densities for any one point in prehistory.
2. Burial. These sites are expected to be focused in certain areas.
3. Major inland trails across many ahupua'a and associated campsites. These sites should be focused in linear corridors.
4. Agriculture in the seaward-most reaches. These sites may tend to be fairly dense but they will again be in a small part of the project area, in the seaward portions.

Archaeologically, the sites should have the following characteristics:

1. Forest exploitation sites. Probably there will be no surface stone architecture (huts and shelters likely were simply pole and thatch). Some campsites will be in caves. Each site may be a small scatter of flaked stone, broken tools, food remains (bone, shell), and firepits. If repeated use occurred, then the density of remains would be greater.
   Such campsites are documented in caves in forest areas. Such cave campsites have yielded a great deal of important information on the age of use of an area, on birds and plants collected. etc. Campsites and exploitation sites have yet to be documented in open-air context, and in such cases, they are expected to primarily be subsurface, buried sites.

2. Burials. Burials in forest areas have been identified in two forms --burials in caves (often caves also used as campsites) and in stone platforms and pavings on cinder cones. These sites contain important information on age of permanent occupation in an area, on social organization, on health, on demography. Additionally, they are highly significant sites culturally for native Hawaiians.

3. Trails. Trails in forest areas are expected to be extremely difficult t o identify, as worn paths and cuts through the forest will have been covered over by later sediments and by forest regrowth. On bare a'a flows, there will be some visible features -- e.g., crushed paths, stepping stones. Campsites along the trails should have firepits, food remains, and some scattered artifacts. Some campsites may have been in caves, but others will have been open-air camps, and may have no surface architecture and be buried like the forest exploitation camps. Trails and their associated campsites can tell us a great deal about the nature of different time periods of travel across regions. Trails also provide information on items being carried or exchanged.

4. Agricultural sites. These sites commonly have some kind of stone-work --small oval clearings lined with stones, small terrace lines, walls, etc. These sites contain important chronological information on permanent settlement of an area, population expansion, and agricultural expansion.

SITE IDENTIFICATION PROBLEMS

Common archaeological surface survey (labelled reconnaissance survey, intensive survey, etc.) can identify cave sites used for forest exploitation and/or burial, can identify agricultural sites, and can identify trails on bare a'a flows. However, cave sites are only expected in older pahoehoe areas, not on a'a flows and not in recent pahoehoe areas. Platform and paving burial sites are expected to be restricted to cinder cones. Agricultural sites will be at lower, seaward elevations in areas with soil. This means that a'a flows and recent pahoehoe flows are not expected to include sites unless there is a visible trail remnant.

The open-air sites in forest areas -- trail sites (and there associated camps) and forest exploitation sites () not in caves -- will likely be subsurface. They will also be small. Common surface survey will not be able to identify these sites when they are subsurface. These sites are expected in soil areas within kipuka, and on old pahoehoe flows, and on older a'a flows lacking rough surfaces.

These sites may be surface remains on bare lava in kipuka, on old pahoehoe flows and on older a'a flows lacking rough surfaces and in such a case common surface survey could identify them; but it appears unlikely that these sites will be found on the surface.

They are not anticipated on rough a'a flows (except rare trails) or on recent pahoehoe or a'a flows. The above problems indicate two special conditions for site identification;

1. Some areas appear not to need survey. - - e.g., rough a'a flows and recent lava flows (post 1880 flows whether pahoehoe or a'a) these areas need to be identified and be clearly marked off as areas needing no archaeological work.

2. Soil areas may contain subsurface exploitation and trail related sites. Special archaeological approaches need to be devised for these areas to try and identify these sites.

BACKGROUND PREPARATION; FINDINGS

1. Check of historic and archaeological literature. The historic literature (Holmes 1985) shows no recorded trails in the project area. The Wilkes route of 1840 (see map number 3) passes to the south of the project area and the Kaimu Trail, approximately .75km to the south skirts south of Heiheiahulu. The existence of the existing Kaimu Trail lowers the probability of an additional trail passing through the study area but increases the possibility that the area was accessed prehistorically.
Previous archaeological surveys done in the general area include Bonk (1990) Haun and Rosendahl (1985). Bonk did not located cultural materials, Haun and Rosendahl identified possible prehistoric Hawaiian burial structures and remnant cultigens of ki, and kukui. The structures were located on the southeast summit of Heiheiahulu located to the southeast of the project area.

2. Identification of older bare pahoehoe flows, soil covered pahoehoe and a'a flows, kipuka and cinder cones and the project area. Holmes' (1985) map of lava flows (see map #4) indicates that the project area is at the north extreme of an 1800's flow with a 750 to 1,000 BP flow north of the site. A recent 1961 flow occurred approximately 1 km to the west of the site. There is just one cinder cone in the vicinity which is located well outside the project area to the north.

3. Identification of cultigens. No aerial photographs were made available to us and hence we cannot offer any aerial interpretations of vegetation areas. However, we did not observe any cultivated plants such as banana, ti, or kukui in the research area.

ARCHAEOLOGICAL SURFACE SURVEY: FINDINGS

1. Caves. The pahoehoe portions of the subject property featured numerous inflated dome type caves - in every case, these were found to be very shallow and devoid of any cultural indications. The property also features a number of cracks. The smallest being one foot wide, three feet long and two feet deep. The largest is roughly 100 feet long, twenty feet wide with depths ranging between 25 and 40 feet. There is a cave entrance at the bottom of the largest crack, however, the area is very unstable, with loose, rotting, rock and debris making even a rappelling exercise treacherous to the point of foolishness. There were no cinder cones within the project area.

2. Kipuka Pahoehoe. There are no kipuka included within the boundaries of the subject property.

3. Trails. The Kaimu trail and the Wilkes expedition trail passed east-west approximately 3/4 to 1km to the south of the project area. The proximity of the Hawaiian trail suggests that an additional trail paralleling this one would be unlikely. However, the proximity may have increased the likelihood of prehistoric access to the project area.

4. Reconnaissance Survey: Methodology. A walkthrough reconnaissance survey was completed for the proposed well site #2. Survey control was provided by Island Survey, Hilo, Hawaii. Control points to which mapping data might be directly referenced were in place along the approximately 3,022 feet of proposed roadway, as well as at the four corners of the proposed well site. A survey team consisting of two individuals made a series of controlled mauka/makai sweeps across the subject property and added a 200 buffer along the south, east and west boarders (the northern boarder is the existing roadway.

FINDINGS

No cultural indicators were located within the boundaries or surveyed buffer zone around the proposed Well Site #2. Survey crew encountered a forest of relatively young Hapu'u, Ohia, Waiwi, on both pahoehoe and a'a flows. Ground visibility was limited by thick fern and root accumulations as well as the remaining uncleared vegetation. Visible ground areas occurred at outcrops of a'a and areas of poorly drained black humus kept free of vegetation by frequent disturbances of feral pigs. Within the well site and buffer zone, direct visual contact with the ground surface or any existing archaeological site features might have been possible only with extensive disturbances of the overlying vegetative and humic layer. Denudation of this sort is not a viable option during the initial stage of research. The sweep method where team members methodically walk in formation from one side of the study area to another, was utilized for all areas where visual contact could be maintained with at least some of the ground surface.
The remaining 90% of the study area was completely covered with a thick, matted layer of uluhe roots (staghorn fern), and humus material up to three feet thick, overlain by .5 to 2 meters of active ulele growth. In this area a series of transects were pushed through the cover in an attempt to identify any evidence of human modification of the landscape. Transects extended in a northsouth direction and an eastwest direction.

FINDINGS

No cultural indicators were located within the well site impact area. There were no sightings of any cultigens such as ki, banana, kukui, within the well site area.

DISCUSSION AND RECOMMENDATIONS

The prediction and identification of temporary forest shelter sites used hundreds of years ago by small groups such as bird feather collectors will be extremely difficult. The illusive temporary camp sites in this upland forest area can be expected to be either buried, random, or so lacking in diagnostic materials that archaeological identification and data recovery may be impossible or impractical unless camp sites used seasonally over many years are encountered. Hypothetically, two types of campsites may be possible in this area, a short term, one-time-used camp site or campsites which were set up along established travel routes and used year after year.

Because no campsites have been identified to date in upland forests, our predictive model continues to be based on a shallow data base.

Archaeological monitoring of soil covered areas after initial grading and grubbing. As a special effort to try and identify subsurface remains of trail and forest exploitation campsites and forest exploitation working areas, this monitoring shall occur. It shall only be done in soil areas. The cuts made during grubbing and grading will be inspected to see if these sites can be identified.

The highest likelihood for locating and identifying campsites in the project area will be during the monitoring of vegetation clearing and earth moving. The presence of features such as developed stratigraphic layers, perishable midden accumulations (charcoal and lithic debris) and foundation outlines, should they exist within the project area, will best be tested during this next phase. In this case, standard excavation methods will be applied.

If there are any questions regarding this report, please feel free to contact us.

Aloha,

Joseph Kennedy
Consulting Archaeologist

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JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

AQUACULTURE DEVELOPMENT PROGRAM
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FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

SEP -5 1990

MEMORANDUM

TO: Michael Buck, Administrator
Division of Forestry and Wildlife

FROM: Manabu Tagomori, Deputy Director

SUBJECT: Botanical Survey of the Proposed Well Site for True/Mid-Pacific Geothermal Venture Located at Puna, Hawaii

Transmitted herewith for your review and approval is a report covering the botanical survey for the new well site selected by True/Mid-Pacific Geothermal Venture (Applicant). The study area and proposed well site are located within the Kilauea Middle East Rift Geothermal Resource Subzone and are shown on the enclosed maps.

Pursuant to the Board of Land and Natural Resources' Decision and Order (D/O) of April 11, 1986, a Biological Survey (of which the Botanical Survey is a part) must be submitted to the Department for approval. As such, we respectfully request a review of the submitted document and a direct reply to the Applicant of your approval and/or comments.

The Department has been informed by the Applicant that the fauna portion of the Biological Survey will be submitted shortly in fufillment of the D/O condition. Please provide the Division of Water Resource Management a file copy of any correspondence concerning the above.

Thank you for your continued assistance. Should you have any questions, please contact me directly at Ext. 87533.

DN:mh

Enclosure

TRUE GEOTHERMAL ENERGY COMPANY

CENTRAL PACIFIC PLAZA

Telephone No.: 808-528-3496
FAX No.: 808-526-1772
220 South King Street
Suite 868
Honolulu, HI 96813

August 27, 1990

Mr. Manabu Tagomori
Deputy Director
Department of Land and Natural Resources
State of Hawaii
1151 Punchbowl Street, Room 224
Honolulu, Hawaii 96813

Dear Mr. Tagomori,

Enclosed is a survey for your information and review. If you have any questions regarding this matter please call our office.

Sincerely,

Glenda C. Perez
Secretary to Allan G. Kawada

BOTANICAL SURVEY
OF PROPOSED NEW WELL SITE #2
BLNR DESIGNATED GEOTHERMAL RESOURCE SUBZONE
MIDDLE EAST RIFT ZONE OF KILAUEA,
PUNA DISTRICT, ISLAND OF HAWAI'I

August 1990

by

Charles H. Lamoureux

PREPARED FOR:

TRUE GEOTHERMAL ENERGY COMPANY

and

MID-PACIFIC GEOTHERMAL, INC.

INTRODUCTION

On 12 August 1990 a botanical survey was conducted of the proposed new Well Site adjacent to the access road to Well Site 1.

METHODOLOGY

The new Well Site is proposed to occupy an area of between 3.5 and 4 acres located within a marked 400 X 400 foot area immediately adjacent to and south of the present road leading from the property boundary to Well Site 1.

At the proposed new well site I examined an area of approximately 800 X 800 feet within which the marked 400 x 400 foot well site was was located.

RESULTS

1. FLORA

All species of vascular plants observed are listed in TABLE I. A total of 73 species and varieties were found, of which 52 (71%) were native, (40 endemic to the Hawaiian Islands; 12 indigenous, native in Hawai'i and elsewhere), and 21 (29%) were species introduced to Hawai'i by humans (1 by the Polynesian settlers, 28 since European contact).

Although a special search was made for the three candidate plants which were formerly proposed for listing as endangered species (U.S. Fish and Wildlife Service, 1980), and which have been reported from the East Rift Zone of Kilauea, (Bobea timonioides, Tetraplasandra hawaiiensis, Adenophorus periens), none was encountered in this survey, and no other plants currently listed or proposed for listing as endangered were found in the surveyed area.

The area surveyed is below the elevation where Adenophorus periens is known to occur in Puna. Furthermore, most of the large 'ohi'a trees in the area belong to the variety macrophylla which has bark that regularly peels off in large strips, and consequently does not develop the thick coating of mosses and liverworts that forms the substrate on which A. periens grows.

Both the Bobea and the Tetraplasandra were encountered along the road leading from the edge of the property to Well Site 1 (Lamoureux et al., 1987). They grow widely through Puna forests as scattered individuals but were not found in the areas proposed for clearing in the current phase of the project. It should be noted that the new "Manual of the Flowering Plants of Hawai'i", (Wagner, Herbst & Sohmer, 1990), reevaluates the status of the flowering plants which were earlier proposed for listing as endangered, based on the most recent information available on distribution, abundance, and taxonomic classification. On this basis Tetraplasandra hawaiiensis is not considered to be endangered, threatened, or even rare. Bobea timonioides is listed as rare, but not threatened or endangered.

2. VEGETATION

The vegetation in the Puna Geothermal Area has previously been mapped and described (Char & Lamoureux, 1985a, 1985b). The site surveyed here is in "ohia-a(2) forest" as described and mapped in those reports. This forest type was described in earlier reports as "Wet 'ohi'a forest with native species and exotic shrubs", and delimited on the vegetation maps in Char and Lamoureux, (1985a) as "ohia-a(2)". This forest is dominated by 'ohi'a-lehua (three varieties of Metrosideros collina, but primarily the variety macrophylla), which forms the canopy layer. Trees are mature, ranging from 20 to 60 feet in height. In a few places the canopy is closed (>60% cover) with most or all trees healthy, in most places the canopy is more open, and in many places most of the canopy trees are dead or declining and dying. In other words there are patches of 'ohi'a dieback in the forest. The subcanopy is dominated in most places by introduced species, primarily strawberry guava (Psidium cattleianum). The major native subcanopy tree is kopiko (Psychotria

hawaiiensis), with occasional hame (Antidesma platyphyllum), and a few kawa'u (Ilex anomala), olomea (Perrottetia sandwicensis) and pilo (Coprosma).

The dominant shrub throughout the area is the introduced weedy Malabar melastome (Melastoma malabathricum), but some native shrubs are also present in relatively small numbers, including kanawao (Broussaisia arguta), mamaki (Pipturus hawaiiensis), 'ohelo (Vaccinium calycinum), Clermontia parviflora, and Cyrtandra sp., (the latter primarily in the numerous cracks and crevices which occur at this site). The introduced thimbleberry (Rubus rosaefolius) is a fairly common but relatively inconspicuous small shrub. Tree ferns, (hapu'u (Cibotium glaucum) and hapu'u 'i'i (Cibotium chamissoi)) are common. The more conspicuous ground ferns are two swordferns, the introduced Nephrolepis multiflora (more common) and the native N. exaltata (less common), two introduced woodferns, Christella dentata and C. parasitica, and the endemic ho'i'o Diplazium sandwichianum.

In more closed parts of the forest the trees, tree ferns, and shrubs support dense masses of epiphytes, including many ferns (listed in Table I), mosses and liverworts. In more open places there are extensive patches of uluhe ferns (Dicranopteris emarginata and D. linearis) 3 to 10 feet deep.

Signs of feral pig activity were found throughout the area. In places where pigs have rooted, and in small open wet areas where they have wallowed, are a number of introduced weeds which are usually not found in undisturbed forest. These include a fern (Athyriopsis japonica), Hilograss (Paspalum conjugatum), a sedge (Cyperus haspan), waterpurselane (Ludwigia palustris), St.Johnswort (Hypericum mutilum), and fireweed (Erechtites valerianaefolia).

3. ENDANGERED SPECIES

No endangered plants (either species already listed or species proposed for listing) were found in any of the areas surveyed.

RECOMMENDATIONS

1. The area now contains a large population of introduced woody shrubs and trees, particularly Malabar melastome and strawberry guava, with a few common guava. It is unlikely that construction activities will have much effect on their abundance or distribution. However, there are several other weeds that could increase in numbers and become more widely distributed as a consequence of opening up the forest as construction occurs. These are the species currently associated with disturbed areas, primarily those disturbed by pigs. Other weeds, not now in the area, could also enter. To avoid this we recommend that:

   a. site clearing methods should be planned to involve as little disturbance as possible beyond the edge of the clearing. This might include using soil and rocks from high points to fill in low spots rather than bulldozing them into ridges at the sides of the clearing. Trees should be felled toward the center rather than the edges of the well site in order to minimize cleared but unused areas which support weeds.

   b. the well site be monitored for weeds, and that appropriate weed control methods be used on all cleared areas, in keeping with the proposed weed monitoring/control program.

2. Our observations suggest that unused open areas at the edges of a clearing are prime sites for weed colonization. Most weedy species require high light intensities to grow well, and such sites are open to full sunlight. If such areas are kept shaded they are less likely to be colonized by weeds. Thus as area cleared should be as small as possible consistent with the function of the site, and unused, unsurfaced areas at margins of the clearing should be as small as possible. During construction if trees are simply

bulldozed aside and, with other vegetation, rocks, and soil are piled up into ridges at the edge of the cleaaring, these rubble piles will soon be covered with weeds. Such areas should be kept to a minimum.

3. Some tree ferns (hapu'u and hapu'u-'i'i) will have to be removed during construction. If feasible, the top foot or two of each fern stem, containing the apical bud, should be retained and replanted along existing road margins or at the edge of this clearing. This would help meet the state requirement that any landscaping be done with native species. More importantly, it would provide a quick source of shade on rubble piles and road margins, which should reduce the weed problem.

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TABLE 1. PLANT SPECIES CHECKLIST

Families are arranged alphabetically within each of three groups: Ferns and Fern Allies, Monocotyledons, and Dicotyledons. Taxonomy and nomenclature of the Ferns and Fern Allies follow Lamoureux's unpublished checklist of Hawaiian ferns; taxonomy and nomenclature of the flowering plants (Monocotyledons and Dicotyledons) follow St. John (1973) except where more commonly accepted names are listed. Hawaiian names used in the checklist are in accordance with Porter (1972) or St. John (1973). For each species the following information is provided:

1. Scientific name with author citation.
2. Common English or Hawaiian name, when known.
3. Biogeographic status of the species. The following symbols are used:

   E = endemic = native to the Hawaiian Islands only, not occurring naturally elsewhere.

   I = indigenous = native to the Hawaiian Islands and also to one or more other geographic areas.

   P = Polynesian = plants of Polynesian introduction; all those plants brought by the Polynesian immigrants prior to contact with the Western world.

   X = exotic or introduced = not native to the Hawaiian Islands; brought here intentionally or accidentally by humans after Western contact.

TABLE 1. PLANT CHECKLIST: NEW WELL SITE 2 AND ITS ACCESS ROAD.

GROUP	FAMILY	STATUS	BOTANICAL NAME	COMMON NAME
PTERIDOPHYTES				
	ASPLENIACEAE			
		I	Asplenium lobulatum Mett.	pi'ipi'i-lau-manamana, 'anali'i
	ATHYRIACEAE			
		X	Athyriopsis japonica (Thunb.) Ching	
		E	Diplazium sandwichianum (Presl) Diels	ho'i'o
	DICKSONIACEAE			
		E	Cibotium chamissoi Kaulf.	hapu'u-pi'i
		E	Cibotium glaucum (J. Sm.) Hook. & Arn.	hapu'u
	ELAPHOGLOSSACEAE			
		E	Elaphoglossum alatum Gaud. var. parvisquameum (Skottsb.) Ands. & Crosby	'ekaha-ula, hoe-a-Maui
		E	Elaphoglossum crassifolium (Gaud.) And. & Crosby	'ekaha-ula, hoe-a-Maui
	GLEICHENIACEAE			
		E	Dicranopteris emarginata (Brack.) Rob.	uluhe
		I	Dicranopteris linearis (Burm.) Underw.	uluhe
	GRAMMITACEAE			
		E	Adenophorus hymenophylloides (Kaulf.) Hook. & Grev.	pai, palai-huna
		E	Adenophorus pinnatifidus Gaud.	
		E	Adenophorus tamariscinus (Kaulf.) Hook. & Grev. var. tamariscinus	wahine-noho-mauna
		E	Adenophorus tripinnatifidus Gaud.	
		E	Grammitis tenella Kaulf.	kolokolo, mahina-lua
	HYMENOPHYLLACEAE			
		E	Callistopteris baldwinii (Eaton) Copel.	
		E	Mecodium recurvum (Gaud.) Copel.	'ohi'a-lu
		E	Sphaerocionium lanceolatum (Hook. & Arn.) Copel.	palai-hinahina
		E	Sphaerocionium obtusum (Hook. & Arn.) Copel.	Palai-lau-li'i
		E	Vandenboschia cyrtotheca (Hillebr.) Copel.	
		E	Vandenboschia davallioides (Gaud.) Copel.	palai-hihi
	LYCOPODIACEAE			
		E	Lycopodium phyllanthum Hook. & Arn.	wawae-'iole
	NEPHROLEPIDACEAE			
		I	Nephrolepis cordifolia (L.) Presl	ni'ani'au, kupukupu, 'okupukupu
		I	Nephrolepis exaltata (L.) Schott	ni'ani'au, kupukupu, pamoho
		X	Nephrolepis multiflora (Roxb.) Jarrett ex Morton	hairy sword fern
	OPHIOGLOSSACEAE			
		E	Ophioglossum pendulum L. ssp. falcatum (Presl) Clausen	puapua-moa
	POLYPODIACEAE			
		I	Pleopeltis thunbergiana Kaulf.	'ekaha-kakolea, pakahakaha
	PSILOTACEAE			
		I	Psilotum complanatum Sw.	moa, pipi
		I	Psilotum complanatum X nudum	hybrid moa
		I	Psilotum nudum (L.) Beauv.	moa, pipi
	THELYPTERIDACEAE			
		X	Christella dentata (Forsk.) Brownsey & Jermy	downy woodfern
		X	Christella parasitica (L.) Levl.	woodfern, oakfern
		E	Pneumatopteris sandwicensis (Brack.) Holtt.	

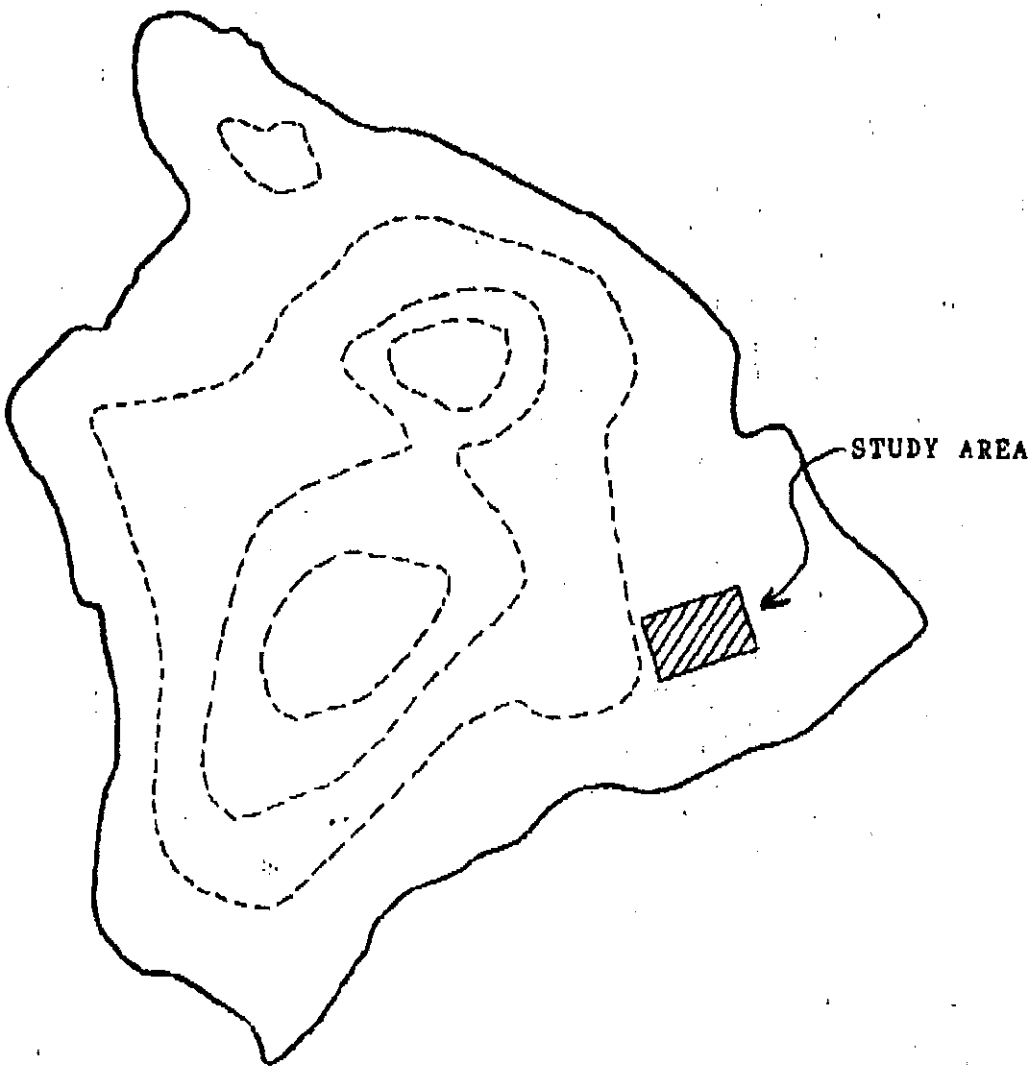
TABLE 1. PLANT CHECKLIST: NEW WELL SITE 2 AND ITS ACCESS ROAD.

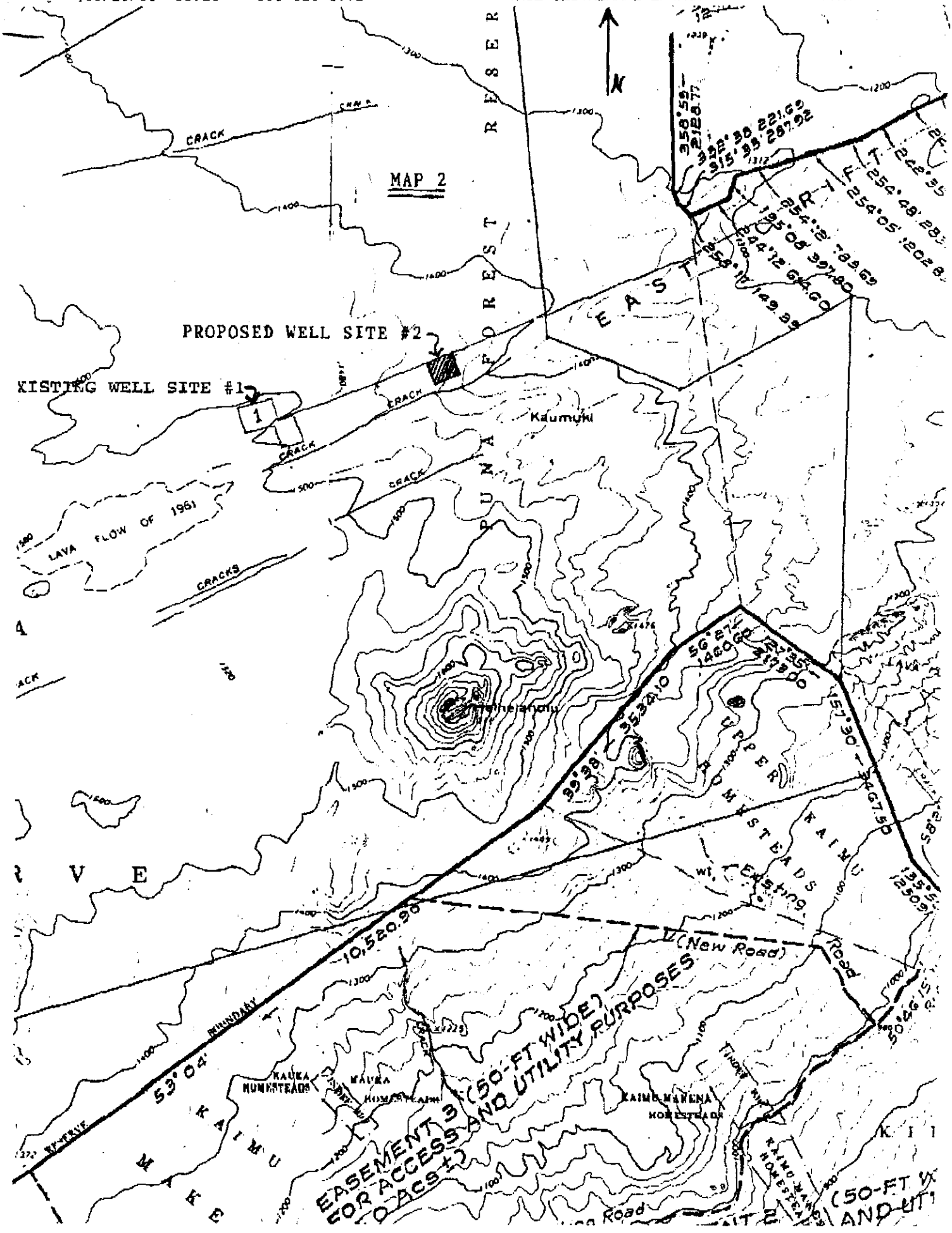
GROUP	FAMILY	STATUS	BOTANICAL NAME	COMMON NAME
MONOCOTYLEDONS				
	CYPERACEAE			
		X	Cyperus haspan L.	
		I	Machaerina mariscoides (Gaud.) Kern ssp. meyenii (Kunth) Koyama	'uki, 'uha-niu
		I	Pycreus polystachyos (Rottb.) Beauv.	
	GRAMINEAE			
		X	Axonopus affinis Chase	narrow-leaved carpetgrass
		X	Oplismenus compositus (L.) Beauv.	
		X	Paspalum conjugatum Berg.	mau'u-Hilo, Hilo grass
	ORCHIDACEAE			
		X	Arundina bambusaefolia (Roxb.) Lindl.	bamboo orchid
		X	Spathoglottis plicata Bl.	Philippine ground orchid
	PANDANACEAE			
		E	Freycinetia arborea Gaud.	'ie'ie
	ZINGIBERACEAE			
		P	Zingiber zerumbet (L.) Roscoe	'awapuhi kuahiwi
DICOTYLEDONS				
	APOCYNACEAE			
		E	Alyxia olivaeformis Gaud.	maile
	AQUIFOLIACEAE			
		E	Ilex anomala Hook. & Arn.	kawa'u
	CELASTRACEAE			
		E	Perrottetia sandwicensis Gray var. sandwicensis	olomea
	COMPOSITAE			
		I	Adenostemma lavenia (L.) Ktze.	kamanamana
		X	Ageratum houstonianum Mill.	ageratum
		X	Crassocephalum crepidioides (Benth.) S. Moore	
		X	Erechtites valerianaefolia (Wolf) DC.	fireweed
	ERICACEAE			
		E	Vaccinium calycinum Sm.	'ohelo-kau-la'au
	EUPHORBIACEAE			
		E	Antidesma platyphyllum Mann	hame
	GESNERIACEAE			
		E	Cyrtandra paludosa Gaud.	
		E	Cyrtandra sp.	
	LOBELIACEAE			
		E	Clermontia parviflora Gaud. ex Gray	
		E	Clermontia hawaiiensis (Hillebr.) Rock	'oha-kepau
	LOGANIACEAE			
		X	Buddleja asiatica Lour.	butterflybush, huelo-'ilio

TABLE 1. PLANT CHECKLIST: NEW WELL SITE 2 AND ITS ACCESS ROAD.

GROUP	FAMILY	STATUS	BOTANICAL NAME	COMMON NAME
	LYTHRACEAE			
		X	Cuphea carthagenensis (Jacq.) Macbride	cuphea, puskamoli
	MELASTOMATACEAE			
		X	Melastoma malabathricum L.	Malabar melastome
	MYRTACEAE			
		E	Metrosideros collina (J.R. & G. Forst.) Gray var. glaberrima (Levl.) Rock	'ohi'a-lehua
		E	Metrosideros collina (J.R. & G. Forst.) Gray var. incana (Levl.) Rock	'ohi'a-lehua
		E	Metrosideros collina (J.R. & G. Forst.) Gray var. macrophylla Rock	'ohi'a-lehua
		X	Psidium cattleianum Sabine forma cattleianum	strawberry guava, waiawi-'ula
		X	Psidium guajava L.	guava, kuawa
	ONAGRACEAE			
		I	Ludwigia octivalvis (Jacq.) Raven	kamole, primrose willow
		X	Ludwigia palustris (L.) Ell.	water purselane
	PIPERACEAE			
		E	Peperomia cookiana C. DC.	'ala'ala-wai-nui
		E	Peperomia hypoleuca Miq. var. hypoleuca	'ala'ala-wai-nui
	ROSACEAE			
		X	Rubus rosaefolius Sm.	thimbleberry
	RUBIACEAE			
		E	Coprosma menziesii Gray	pilo, kopa
		E	Coprosma ochracea W. Oliver	pilo, kopa
		E	Psychotria hawaiiensis (Gray) Fosb. var. hawaiiensis	kopiko
	SAXIFRAGACEAE			
		E	Broussaisia arguta Gaud.	kanawao
	URTICACEAE			
		E	Pipturus hawaiensis Levl.	mamaki

MAP 1




MAP 2
PROPOSED WELL SITE #2
EXISTING WELL SITE #1
1
CRACK
LAVA FLOW OF 1961
CRACKS
Kaumuki
Kaimuhenaonu
KAUKA HOMESTEADS
KAIMU-MAKENA HOMESTEADS
10,520.90
53°04'
EASEMENT 3 (50-FT WIDE) FOR ACCESS AND UTILITY PURPOSES
(New Road)
Road
BOUNDARY
KAIMU
MAKENA

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

KEITH W. AHUE
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
STATE HISTORIC PRESERVATION DIVISION
33 SOUTH KING STREET, 6TH FLOOR
HONOLULU, HAWAII 96813

January 7, 1990

MEMORANDUM

TO: Manabu Tagomori, Deputy Director
Commission on Water Resource Management

FROM: Don Hibbard, Director, Historic Preservation Program

SUBJECT: Historic Preservation Review of True Geothermal Energy Company Proposed Well Site #2 (KMERZ)
Former Puna Forest Reserve, Puna, Hawaii
TMK: 1-2-10: 3

HISTORIC PRESERVATION PROGRAM CONCERNS:

Attached for your review and comment is our summary of the major points agreed upon at our December 27, 1990 meeting with representatives of True Geothermal Energy Company. We have also addressed what we feel were some misunderstandings about our review process in general and how it is being applied to this project.

Please contact either Holly McEdlowney (587-0008) or Ross Cordy (587-0012) if you have any questions regarding the review or wish to suggest any changes before final processing by the Department.